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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to ensure publication in that week's issue.

Why should not some of our rich and public-spirited men contribute to a fund and endow a chair of technology at Washington? With free tuition and a few well-balanced hammers some of our legislators might thus be coached into a proper understanding of the many worthy measures proposed for the advancement of our country's interests. A recent example shows a case of obstruction needing such education. The Pacific cable was objected to merely because, forsooth, in a few years the wireless system might be made practicable and messages sent ricocheting across the waters, meanwhile letting commercial business and progress go to the bow-wows.

THE INSTITUTE CONVENTION.

The Great Barrington meeting of the American Institute of Electrical Engineers is already, as time flies, reckoned an event of the past. But what a marked period in the history of the Institute is this meeting likely to be. It is the greatest meeting the Institute has held in so far as attendance and the completeness of the arrangements can be said to be distinguishing elements, and it is not too much to say that time may prove it one of the greatest meetings of the Institute in point of the value of the papers presented.

The Great Barrington convention will long be remembered also for the exceptional success attained in bringing the families of its members into such grateful social intercourse with the hospitable people of a grand section of a great state. Each element of the social programme was a gem of a lustre all its own. Every event passed off in most pleasing harmony with the general sitting. And the action of the Institute in presenting a loving cup to the ladies of the Thursday Morning Club will appeal to all as one of the most graceful acknowledgments it has been the good fortune of the Institute to make. The presentation ceremony was dignified and inspiring, and the loving cup will perpetuate in no small measure the pleasures of the season just closed.

The attendance of the membership was especially fine. The sessions were all good ones in point of numbers and the papers possessed the excellence that holds attention once attracted.

Members who have gone to great pains in the preparation of papers have for once at a general meeting faced audiences commensurate with the importance of the matters discussed. The papers were uniformly strong, but were after all but the setting for two events of unusual importance.

One was the spontaneous outburst of interest and admiration that greeted the impromptu announcement by Mr. Bion J. Arnold of the new system of electric traction for application to railways operating under trunk-line conditions. In entering upon this radical departure from all previous practice Mr. Arnold is at once so novel and so bold in the methods he applies that he has the attention, and, we feel certain, the good wishes of all.

We have been long awaiting the direct application of high-tension alternating currents to electric traction. At last the time seems ripe and the ability present.

The second event of the convention centered about the presidential address dealing with electrical engineering education. The discussion induced certainly accomplished the result for which it was presumably brought about.

Mr. Steinmetz sounds a note of warning to be commended when he calls attention to the fact that it is high time to retrench and examine carefully the position now held as the result of the wide acceptance of the results, the methods and the theories propounded by empirical science.

He calls to this work of examination the younger generation of scientists and engineers, the men, in fact, who can take up in an unbiased way a searching criticism. Men to be fitted for this undertaking must have strenuous and exact training, and it has been to this training that attention was directed. In this discussion, as never before, the men in practice and the men in education have met and seriously considered the question of the proper training for the electrical engineer.

The Great Barrington meeting is a distinct step forward. May the good work continue.

TO BURY THE TROLLEY WIRES IN BROOKLYN.

It seems that at last the authorities of the big borough across the bridge are awakening to the metropolitan idea of getting the railway feeders underground.

Years ago the management of the telephone interests of Brooklyn set the pace, but nothing came of it as to the power wires. Good fortune, rather than any law of chance, has favored the railway companies and the overhead cables which web the air of Brooklyn have not yet let loose the forty or fifty thousand horsepower which pulses through them. Fires have occurred, some people have been shocked, but no great harm has occurred. Perhaps none will, and we hope so. But the overpowering reasons which, in Manhattan long ago, compelled all such wires to go into conduits are just as strong in Brooklyn. This is especially true of those sections near the bridges and the various power-houses, where almost every street is lined with an ominous array of the big black and ugly feeders. Many of them are probably more than eleven years old and storm-worn. Additional feeders and auxiliaries go up from time to time, and but add to the burden of risk to the public.

We do not say all this from the sensational standpoint. The feeders in thickly settled Brooklyn should come down. Taxpayers in Brooklyn are entitled to the same return for their money as those in Manhattan, and ought to get at least this part of it.

THE BRIDGE PROBLEM.

After many months waiting, and innumerable columns of matter in the daily and Sunday press, it is a fair question to ask what is being done in the matter of the Brooklyn Bridge passenger crowding. We refer particularly to the handling of motor trains on the bridge, not the trolley cars.

Dozens of plans have been published, involving all sorts of changes of the Manhattan terminal and most of them regardless of cost, but all apparently arrived at some big increase of traffic capacity at some distant future time. The announced plans of the Bridge Commissioner took no account of the one crying want of some immediate relief of the congestion of passenger traffic. The present conditions are intolerable and almost beyond human endurance. Here in the greatest and most progressive city on earth, with the highest-priced set of officials to be found in the world, apparently not enough ingenuity can be got to work to surmount the difficulty and relieve a situation which elsewhere would not be tolerated for a month.

A little sincerity, some push and good intention and a few thousand dollars expended at once would improve the conditions materially. Will not the Mayor or the Commissioner see that an effective remedy is applied at once?

CHARLES T. CHILD.

It is with the deepest grief that we announce the death of Charles Tripler Child, the Technical Editor of the ELECTRICAL REVIEW. A brief outline of the interesting career of this brilliant electrical engineer and writer is given on another page of this issue. His death means the irrevocable loss of an associate whose many charms of intellect and heart had won our lasting affection.

Few electrical writers could so clearly and intelligently discuss technical subjects, and few were so well equipped for this purpose by education and experience.

Many expressions of regret have already come to this office. His death is recognized as a distinct loss to the profession he loved and to which he was giving the conscientious service of a mind of high scientific ideals that seemed to possess a prophetic comprehension of the future of electricity.

THE ELECTRICAL ENGINEER.

[*Editorial from the N. Y. Sun.*]

To many a boy of sixteen or seventeen who is beginning to ponder what part in the world he can play best or what part is the best to play, the convention at Great Barrington of the American Institute of Electrical Engineers must have seemed the great and most interesting thing of last week. To men, also, the new profession is fascinating; and it draws irresistibly to itself much of the best talent of the time. It is not too much to say that no other profession is likely to do so much for the material progress of mankind in this century. Electrical science is still in its swaddling clothes. Wonders beside which the tales of Sinbad and Aladdin are but last year's almanacs may be and are expected of it. Transportation, manufacturing, domestic economy are yet to be revolutionized by it. The age of steam should seem slow, moss-backed and dull in comparison with the age of electricity.

And that, in its turn, may have to yield the palm to some discovery of later and wiser ages. The world has crept and walked long. Now it is a lightning express.

This same wonder of wireless work is possibly destined to further feats in the great future of scientific civilization. Not merely in the way of beautiful laboratory phenomena, but rather in the domain of human wants and practical industry. Along Tesla's lines, why can not large quantities of electrical energy be transmitted as well as the pigmy potentials now successful? Should it be any more difficult than the development of the giant steam hammer used on armor-plate from the little tack-driver Artemus Ward used to fatten his thumb?

The annual convention of the Independent Telephone Association of the United States of America has met with the characteristic hearty welcome from Philadelphia, which has made its gatherings significant of popular good-will in the past. These are the men who have done much, and are doing much, for progress in their field. A feeling seems to have been extant that this year's session would not equal those of days gone by, but this atmosphere of doubt has been happily dispelled by the large attendance and interest evidenced at the opening session on Tuesday morning of this week.

THE DEATH OF MR. CHARLES T. CHILD.

Mr. Charles Tripler Child, technical editor of the ELECTRICAL REVIEW, died at 1.15 A. M., Monday, June 23. On June 2 Mr. Child was taken with malarial fever, and was confined for a week at his residence in Montclair, N. J. Feeling somewhat better, and believing with his physician that the change of air would be beneficial, Mr. Child, with his family, visited his father-in-law, the Rev. John R. Cushing, at Gleasondale, Mass. There he suffered a relapse, and typhoid fever developed and although the best of medical skill and loving care were provided, he passed away at an early hour on Monday of this week. Mr. Child leaves a widow and three small children—one daughter and twin sons.

The funeral services were held at Rev. Dr. Cushing's residence at three o'clock Tuesday afternoon. The remains were interred Wednesday afternoon, at Richmond, Va.

Mr. Child was born in Richmond, Va., November 1, 1867, and consequently was in his thirty-fifth year at the time of his death. His education was conducted by a private tutor until his entrance at Richmond College in 1880. His studies were confined to mathematics, physics, chemistry, English, French, German, Latin and Greek. Leaving this college in 1885 he entered the Johns Hopkins University as a special graduate student in physics and mathematics under Professors Rowland, Clark and Franklin. The next year he was a member of the newly organized class in electricity, under Dr. Louis Duncan, and had also a course in chemistry.

In the summer of 1887 he entered the service of the Sprague Electric Motor Company, in New York city, performing all the details of motor construction so as to become familiar with the practical work of a manufacturing shop. In the autumn of the same year he was in charge of the wiring and equipment of the cars for the Richmond Railway and Electric Company's historical railway line, of which Mr. Frank J. Sprague was the builder.

Desiring to acquire experience in the operation of electric lighting apparatus he went, early in 1888, to Kansas City, Mo., and entered the service of the local electric light station as a laborer, becoming in turn fireman, dynamo tender, switchboard hand, lineman, lamp trimmer, wireman, stock-keeper and assistant to the superintendent. After a year spent in acquiring this experience he returned to New York, where be became office engineer for the company building electric railways under the patents of Mr. Leo Daft. He made the specifications and supervised the construction of twelve electric railway installations, took part in the experimental work in heavy electric traction conducted on the elevated railway system of New York, and in the operation of the first storage battery traction lines in the United States, at Toledo, Ohio, Newark, N. J., and in Madison avenue, New York.

CHARLES TRIPLER CHILD.

Upon the liquidation of this company, in 1891, he went to Richmond, Va., and formed, with a number of local parties, a manufacturing company for the construction of dynamo machines and motors, and the construction and operation of a water-power, electric light and power supply station. This concern did an excellent business and was, the next year, consolidated with other electric lighting and railway enterprises in Richmond. He designed and built for this company many types of direct and alternating-current apparatus, including the lighting alternators used in its central station service.

Going to Washington, in 1892, he became aid-in-charge of the United States Astrophysical Observatory of the Smithsonian Institution, wherein were conducted, under his supervision, the elaborate researches of Professor S. P. Langley on the infra-red solar spectrum employing the bolometer and other electrical apparatus. Much of this he designed and constructed.

Leaving this service the next year to conduct experimental work for the development of certain of his patents on electrical apparatus, he was later recalled to Washington to reorganize the research work of the observatory. This being accomplished, he returned, in 1895, to his home at Richmond, Va., and opened an office for the practice of consulting electrical engineer. He designed the plant and equipment of the Richmond Traction Company and the telephone exchange of the Richmond Telephone Company, then the largest independent telephone exchange in the world.

In 1897 he was tendered editorial charge of the *Electrical World*, of New York, a position resigned some two years later for a similar connection with the *Engineering Magazine*. Early in 1899 he became technical editor of the ELECTRICAL REVIEW, which position he held until his death.

The honorary degree of B. Sc. was given Mr. Child by his *alma mater*, Richmond College, in 1893. He was a member of the American Institute of Electrical Engineers and of several other technical and scientific societies.

Mr. Child was a linguist of marked ability, carrying on a correspondence in their languages with several of the leading electricians in France, Germany and Italy, and translating their technical treatises contributed to the ELECTRICAL REVIEW or published in foreign journals.

For some time prior to his death, Mr. Child had been engaged in preparing a book entitled "The How and Why of Electricity." The manuscript of this work is believed to have been completed and will no doubt be published. It was the intention of the author that this should be a book for non-technical readers and for busy men.

Mr. Child possessed a wide acquaintance, and his death will be mourned by a host of friends throughout the electrical fraternity of the world.

THE CONSTRUCTION OF SMALL TELEPHONE EXCHANGES—XXX.

BY A. E. DOBBS.

Fig. 126, given in a previous chapter, shows one cam as performing, by means of a rocking motion, both the ringing and listening functions. A great many exchange managers and manufacturers, however, do not think this desirable, and the keys for different purposes are, therefore, often assembled as separate parts. Fig. 127 shows a form of key which is used solely as a ringing key, and as will be seen, rocking the handle forward depresses the plunger, thus opening the connection with the inside springs and breaking the opposite cord contact connects to the ringing or generator springs on the outside in precisely the same manner as shown by the sketch in Fig. 126. The operator's listening key, shown in Fig. 128, is arranged on the same principle, except that in the form shown, it bridges in on the line in a manner similar to the listening key shown diagrammatically in Fig. 131.

As said before, the form shown in Fig. 126, with either a single or double key equipment, is nearly always sufficient for ordinary exchange work for the operator, as already indicated, answers all calls with the back plug; throwing the cam over, places her in connection with the calling subscriber. Having learned his number, she then inserts the front plug in the called-for line jack and rocks the ringing key back which rings only on the front or calling cord, thus ringing the party wanted. This is generally sufficient, for when a subscriber calls for a connection he is presumed to remain at his telephone until the called party answers. If, however, the party called should not answer until the calling party has got tired waiting and left his telephone, the operator would have to reverse the plugs in order to ring him back to his instrument again. In order to obviate this feature, which is something of a disadvantage, some manufacturers place an extra push-button alongside of the ringing cam intended to give a ring on the back cord. As this push-button is not often used, it is set in the table alongside the cam lever and hence is inconspicuous.

When we come to toll-line work, however, the conditions are different, for it often happens that there must be an exchange of orders between operators, the parties must be separately called and enquiries made as to whether they are ready, this owing to the fact that the minutes during which they are engaged in conversation are counted. Therefore, the operator should be able to ring either the front or back cord, and also listen in, on either the front or back cord, for the purpose of making enquiries, or helping the connection in other ways. To meet this

Fig. 127.—Ringing Key.

condition of affairs, it is necessary that there should be quite a number of contacts in series. Thus the front and back listening key, if it breaks both sides of the cord circuit, as it should do, involves four

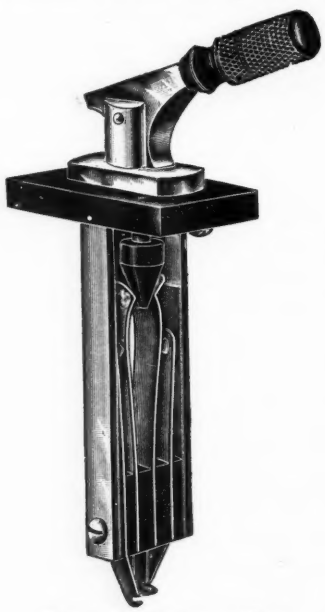


Fig. 128.—Listening Key.

movable contacts in order to enable the operator to cut out either the front or the back cord. Similarly the ringing key also makes four more breaks in the circuit, so that between the two there are eight in all. Some manufacturers have reduced the number of breaks in the circuit by bridging the operator's listening key on the line, but while this reduces the number of spring contacts by four, yet the trouble experienced by the operator in getting orders over the lines while the listening subscriber can hear everything she says makes the series contacts preferable. The ringing key is also often so arranged as to break one side of the cord circuit only thus still further reducing the number of spring contacts to two, but in long, leaky lines this gives a disagreeable back ring in the subscriber's ear besides making trouble in other ways.

In Fig. 129 we have two sets of double keys presenting an awkward appearance diagrammatically, beauty being sacrificed for the sake of clearness in drawing. In this figure, as in 127 and 128, the springs are spread apart by the insertion of a wedge-like plunger.

As will be seen, the short springs in the centre keep the cord circuit closed and when the long springs are forced apart by the plunger, one cord is cut out by the opening of these centre springs, and the long springs being spread out against the two springs on the outside, the cord in connection with them receives a ringing or talking current, as the operator elects.

Thus these two long springs not only perform the function of opening and changing the circuit, but also force the plunger back when the cam lever is released.

To begin with the front listening key, it will be seen that pulling the rocking lever to the left cuts out the back cord, which connects through the interior springs, and throws the operator in connection with the front cord only; on the other hand, throwing the rocking lever back cuts out the front and connects her with the back cord. The same plan is also carried out in the ringing keys, the only difference being that the generator is connected to the normally open contacts instead of the operator's listening circuit. It will also be observed that the clearing-out drop is bridged on to the middle of the circuit across the two cords.

Lest this system might seem complicated enough to frighten away some of our younger readers, we show in Fig. 130 the meanderings of one strand of the cord through this apparent maze of contacts. Beginning at the left, the single strand of the cord, called the front sleeve side—meaning thereby the strand of the cord that connects with the sleeve of the plug—follows through the main spring

of the front listening key, through the inside spring, through the main spring of the front ringing key, to the inside spring of the same, and thence it returns to the back listening key, which divides the two cord circuits. From the back listening key it continues to the inside spring of the back ringing key, and thence to the

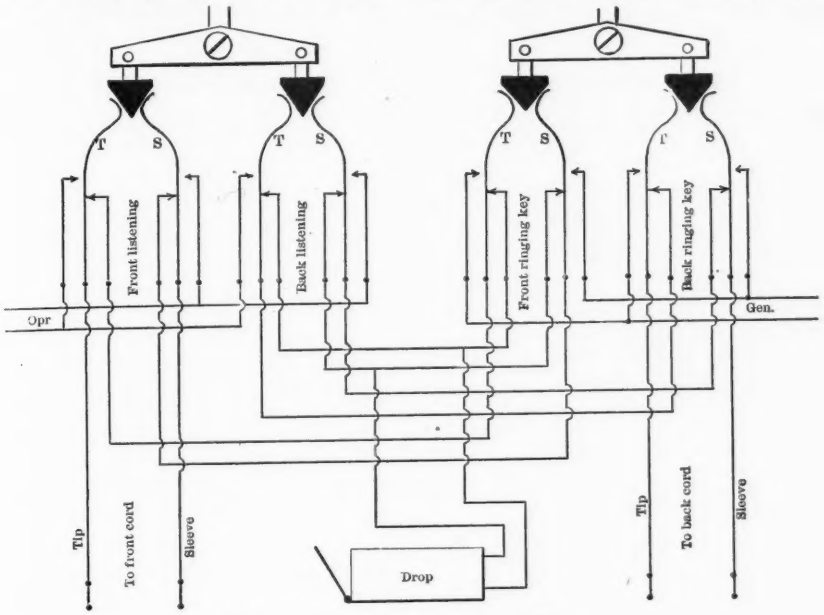


FIG. 129.—TWO SETS OF DOUBLE KEYS.

back sleeve connection of the cords. In order to distinguish between the sleeve and tip connections of the cord, the two strands are generally colored differently, as white and brown, brown and red or white and red. If, for example, it is agreed that the white strand of the cord shall be connected to the tip of the plug, and the red strand to the sleeve, this order of connection should be followed throughout every pair of cords on the board, in order to facilitate the tracing of connections and prevent cross-connections, which would create trouble.

As said before, the number of contacts, eight in number, in a cord circuit, is an objectionable feature and quite a frequent source of trouble, as there are eight possible chances for an open contact in the key connections between each pair of cords, but in toll lines it is equally important that the operator should be able to break the circuit in either direction, which can not be done without series contacts. This multiplicity of connections makes the task of the switchboard inspector more difficult, for as the number of wires increase the chances of trouble also increase. But the board is generally wired and carefully tested before leaving the factory, so that if silk-covered wire is specified in the order for the board wiring, trouble from crossed wires rarely occurs.

In the assembling of these keys conscientious manufacturers use strong German silver springs which make contacts through platinum points, which while not entirely preventing open-circuit troubles reduce them to a minimum, so that everything considered trouble in a well made key is surprisingly small.

In the assembling of the different parts of a key the insulation between the different springs should be carefully looked after, and up to the present time there are only two substances found that afford a satisfactory insulation—hard rubber and mica or some of its forms, as micanite. Imitation rubber, being a fibrous material, will absorb moisture as will also hard fibre and all kinds of paper composition. They should therefore be tabooed.

The key should also be strong mechanically, as it is subject to a great deal of hard wear. The handle of the cam should be well insulated to prevent the possibility of the operator's receiving a shock from high-tension currents. The movements of the cam should also be free from friction and stiffness in order to allow of quick and easy action on the part of the operator.

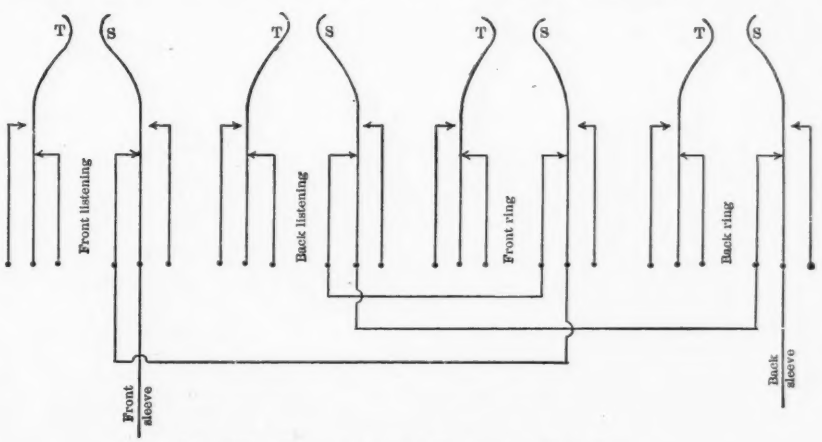


FIG. 130.—FOLLOWING THE CIRCUIT OF ONE CORD.

Steam Raising from Refuse.

The combined refuse destructor and electric generating works at the Grays-Thurock works in London consists essentially of two steam sets of 100 kilowatts each at 460 to 500 volts, a balancer booster and a battery of accumulators. The boiler room contains two thirty-foot by eight-foot Lancastershire boilers adapted for coal firing. These are used only when there is an insufficient supply of refuse to burn in the destructor. The destructor house is separated from the main boiler house, and contains two two-grate Meldrum regenerative simplex destructors, working in conjunction with a Lancastershire boiler twenty feet by seven feet, and a regenerator for heating the air supplied to the furnaces.

The gases, after leaving the furnaces, pass through a combustion chamber where most of the dust settles, then through the boiler flues and regenerator, and into the chimney, either direct or through an economizer. The plant is arranged so that the dust may be raked out of the combustion chamber and boiler down-take and generator, and can therefore be run for about three months without stoppage.

The maximum load on the station is eighty kilowatts, and this is easily maintained by the consumption of about two tons of refuse an hour. On an average, twelve tons of refuse per day (of six hours) are burned. Two stokers and a trimmer are employed, so this averages one ton per hour per stoker, which means very easy firing, as double this duty might be obtained. The maximum output in kilowatt-hours per ton averages about thirty-five. Neither smoke nor dust is visible from the chimney, nor is there any objectionable odor evident in the locality of the destructor.

Convention of Electrical Engineers.

A Report on the Technical Features of the Annual Convention at Great Barrington, Mass., June 18 to 21, 1902.

By George F. Sever.

THE NINETEENTH ANNUAL CONVENTION of the American Institute of Electrical Engineers was held at Great Barrington, Mass., from June 18 to 21 inclusive, the headquarters of the Institute being at the Berkshire Inn, where the papers were presented for consideration and discussion.

The Institute was particularly fortunate in having presented for its consideration some papers of great individual merit and value. The paper presented by Mr. Arnold, and that of Mr. Mailloux, in which he demonstrates the speed-time curves for the calculation of railway motor equipments, were particularly valuable and instructive. The report of the committee on standardization presented at the Friday's meeting embodies some new material which has been needed for some time and is now settled upon by its acceptance by the Institute. The meeting of Saturday, at which were presented papers on the education of the electrical engineer, showed wide differences in opinion, and the discussion by practising engineers, manufacturers and educators showed an even wider variation than was evidenced in the prepared papers.

There was a notable lack of discussion of direct and continuous-current apparatus, the only paper to be presented on this subject, outside of the electric railroad papers, being that by Mr. G. F. Packard. This covered a discussion of a particular variable reluctance method of motor-speed control. It was unfortunate that this subject was not treated more fully, as there are at present some unsolved problems in the study of speed control and speed variation in direct-current motors. The alternating-current problems and phenomena which were presented for consideration were of great interest and formed the largest part of the papers and discussions submitted to the convention.

WEDNESDAY'S SESSION.

Considering the different days' proceedings, we can start with the meeting of Wednesday morning, at which were presented in the following order papers covering alternating-current problems: "A Method of Compounding Alternating-Current Generators and Motors, Direct-Current Generators, Synchronous Motor-Generators and Synchronous Converters," by Frank George Baum; "Formula for Calculating the Electromotive Force at any Point of a Transmission Line for Alternating Current," by M. Leblanc; "The New Generating Plants of the Niagara Falls Power Company," by H. W. Buck; "Notes on the Theory of the Synchronous Motor," by Charles Proteus Steinmetz.

Mr. Baum's paper described a method of compounding alternating-current dynamo electric machinery, such as generators and motors. Essentially the system involves the use, besides the ordinary exciter, of another machine, whose field is placed in series with the line of current of the generator. The armature of this second machine has a current-collecting device which sends impulses of current through a secondary winding on the ordinary exciter's field, thus increasing its potential as the increased load comes upon the main generator. It would appear as if the introduction of a second and special exciter would create complications which, under ordinary circumstances, would detract considerably from the value of the easy operation of the station. Certainly the results which are shown by the use of this method of regulation are excellent.

The second paper of the morning, by M. Leblanc, presents for the first time the complete equation for calculating the electromotive force at any point of a transmission line using alternating current. The equation is quite formidable, but points out that it is quite necessary to prevent the production of harmonics by the generating and receiving apparatus, and leads to the conclusion that on a long-distance transmission line low frequency should be employed.

Mr. Buck's paper on the development of the Niagara Falls Power Company presented for consideration the large engineering features of that company's plant. He stated that the first type of generators, with the external field, was to be supplanted by the internal revolving field type, built in accordance with modern methods. Almost all modern machines of large size employ the latter type and the Niagara Falls Power Company has felt that it is to its advantage to employ this in the new machines which are to be installed in power-house No. 2. The figures as to the efficiency given for the external field generators of the new type are interesting, as showing the small losses which occur in modern electrical machinery. According to the figures given, the guaranteed efficiency at full load is ninety-eight per cent, and from actual test the full-load efficiency is 98.15 per cent. This so closely approaches the efficiency of alternating-current transformers as to be a very remarkable feat in electrical engineering design and construction. For the first time there is brought to our attention the use of a 10,000-horse-power three-phase generator, which the Canadian power plant of the company is to install. There are to be a number of these erected in the Canadian station, and it is interesting to learn that these machines occupy very little more space than the 5,000-horse-power units which are installed on the American side. These large units will be of the internal field type and are very simple in their construction details.

The arrangement of the switchboard provoked some interesting discussion between the advocates of the bench-board system and the ordinary system where the operator works directly with the apparatus placed in front of him on the panel.

Mr. Steinmetz's paper on the phenomena of surging in relation to synchronous motors presented for the first time this interesting fact, both mathematically and graphically treated, and furnishing valuable material for the further study of these phenomena.

THURSDAY'S SESSION.

Thursday morning was devoted to the subject of the electric railway, and the following papers were presented for consideration and discussion: "A Study of the Heating of Railway Motors," by A. H. Armstrong; "Comparative Acceleration Tests with Steam Locomotive and Electric Motor Cars," by B. J. Arnold and W. B. Potter; "Method of Ascertaining by Means of a Dynamometer Car the Power Required to Operate the Trains of the New York Central & Hudson River Railroad between Mott Haven Junction and Grand Central Station, and the Relative Cost of Operation by Steam and Electricity," by Bion J. Arnold; "An Experiment with Single-Phase Alternators on Polyphase Circuits," by C. O. Mailloux; "Speed-Time Curves for Electric Railways," by C. O. Mailloux.

The purpose of Mr. Armstrong's paper was to discuss some of the variables met with in the operation of railway motors and their influence upon the motive power and station output for the various speed schedules. This is an admirable contribution to the literature of the railway-motor problem, as it presents engineering data regarding the heating of railway motors. The author attempts to outline a method for determining the probable heating and energy consumption of a given equipment for any class of work.

At this session Mr. C. O. Mailloux presented his paper on the speed-time curves of railway motors, showing the development of the speed-time curve for acceleration, drifting and braking. His treatment of the subject was most valuable, and will become a means by which engineers and others may learn concerning the operation of railway train units and the schedules which may be best adapted for any given problem.

Mr. W. B. Potter discussed the interesting fact that passengers can stand a much higher rate of acceleration than is ordinarily met with, if that acceleration is reached at a slowly increasing rate. In other words, a passenger can ordinarily stand the rate of acceleration of two miles per hour per second, but a rate of four miles per hour per second would not be inconvenient if this acceleration could be reached through a slow rate of acceleration.

The joint paper by Mr. Arnold and Mr. Potter is interesting as showing the difference in acceleration with steam and electric motor cars. They show that the electric motor has the advantage in being able to cover the same distance in the same time with less energy expended and at less maximum speed than the steam locomotive.

Mr. B. J. Arnold's paper, covering his investigations for the New York Central & Hudson River Railroad on the electrical operation of trains through the Park avenue tunnel, presents facts which are very important to the engineering world. It is part of his report to the directors of the New York Central Railroad, and being published by their permission, might be considered as being acceptable to them. Although the difference in operation costs between steam and electricity, as estimated by Mr. Arnold, is only 0.55 of a cent per locomotive mile, the distinct advantages which would accrue to the road from the assumed absence of danger, from the great convenience and the pleasanter method of traveling, would go far to make up for this small difference in operating expenses. The method which Mr. Arnold proposes is interesting as showing the use of direct-current locomotives operating at 600 volts with the power station located near the Harlem River, and using a substation placed near the Forty-second street end, storage batteries to be utilized for equalizing the load. A further interesting fact is that direct-current energy, when brought from an alternating-current system, costs one-half cent more per kilowatt-hour than the alternating current power. The whole object of Mr. Arnold's paper, which is a classic, was to find the work to be done in moving the trains from Mott Haven to Forty-second street, and from this data to ascertain the weight of locomotive and the advisability of handling the traffic with such a unit.

Mr. Sprague, in the discussion, considered

that Mr. Arnold's paper was the most important one of the meeting as indicating an essential advance in the application of electric locomotives to the successful haulage of heavy and frequent trains in a congested district, and he also pointed out that economy was of no importance in the problem, but that the operating expenses would undoubtedly decrease with greater comfort afforded to the traveling public by the installation of electrically operated trains.

Mr. F. S. Pearson pointed out, in the further discussion, that the long-distance high-speed problem is now before us for consideration, and especially as the steam locomotive is limited by its boiler capacity. Owing to this fact, the limits of high speed with steam locomotives is nearly reached, and, therefore, with the road-beds and the cars available for high-speed traffic, it will be necessary to look to electricity to accomplish the final results.

During this railway meeting Mr. C. O. Mailloux presented his paper on an experiment with single-phase alternators on polyphase circuits. This was a record of his experience in operating two single-phase alternators on a two-phase system running rotary converters. In the discussion it appeared that at Ottawa, Canada, a similar arrangement was utilized giving satisfactory results, and Mr. Steinmetz very clearly pointed out the reason for being able to operate single-phase apparatus on a two or three-phase system satisfactorily. To use his own words, if the diagrams which represent the relations of the electro-motive forces on the machines are mechanically stable then the apparatus will be electrically stable. For instance, an equilateral triangle representing a three-phase system is mechanically stable and if single-phase alternators are properly connected to a three-phase system they will, although driven by independent prime movers, operate successfully.

FRIDAY'S SESSION.

The papers on Friday were as follows: "The Function of Shunt and Series Resistance in Lightning Arresters," by Percy H. Thomas; "The Electrostatic Wattmeter in Commercial Measurements," by Miles Walker; Energy Loss in Commercial Insulating Materials When Subjected to High-Potential Stress," by Charles Edward Skinner; "Report of the Committee on Standardization;" "The Determination of Alternator Characteristics," by L. A. Herdt; "A New Curve Tracing Instrument," by Professor R. B. Owens.

Mr. Thomas showed the use of both shunt and series resistance in the successful operation of lightning arresters for high-tension transmission lines and circuits. Mr. Steinmetz, in the discussion, stated that the three essentials of successful lightning arresters were: First, series resistance; second, a multiplicity of spark-gaps; and, third, large terminals so that the heat might be rapidly conducted away from the point of arcing. An ideal lightning arrester would include no resistance, but this is impossible owing to the vicious short-circuiting which would occur, causing bad surging and burning. It was also shown that there is required a smaller voltage to maintain the arc than is required to strike the arc. Therefore, if there were means for increasing the resistance of the circuit after the arc had established itself, the effects on the line as to surging and the burning of the lightning arrester would be greatly decreased. Such an arrangement might be accomplished by utilizing a smaller number of gaps over which the spark would pass, and then increasing the number in order to break the current.

Mr. Skinner's paper on the energy loss in insulating materials showed that the loss in insulating materials under these conditions was considerable and led to the final breaking down of the insulation.

The conclusion reached from the discussion would seem to show that there are innumerable paths in the insulation due to the interstices and occluded air, also that within the electrical elastic limit of the material the law that the loss of energy is proportional to the square of the voltage would seem to hold. This is a valuable and interesting point, especially when considered in connection with underground and submarine cables.

The standardization report was then presented before the Institute for its consideration and adoption. The most important recommendations are as follows: The adoption of a formula by means of which the rise in temperature of dynamo electric machinery above the surrounding atmosphere can be definitely secured. A closer value for the temperature coefficient was recommended.

The section relating to the rating of railway motors was changed so that the horse-power output, which gives a seventy-five-degree centigrade rise of temperature above a room temperature of twenty-five degrees centigrade, after one hour's continuous run of 500 volts terminal pressure, on a stand, with the motor covers removed, shall be the official rating. An important recommendation was that relating to alternating-current circuits where the frequency of 30 to 40 are omitted and frequencies of 25, 60 and 120 are recommended as desirable. The section on luminous sources is entirely new and recommends the use of the Hefner unit in preference to that of the British candle-power. This is an excellent recommendation and it is hoped that all engineers may recognize its importance. In the discussion it was learned that one Hefner unit was equivalent to 0.88 of a British candle-power and that this unit is sufficiently accurate to be adopted as a standard. Mr. J. W. Lieb showed that the mean spherical candle-power is the most desirable method of recording luminous sources, both for commercial and scientific purposes, and this idea was borne out by the further discussion of the subject.

Professor Owens read Professor Herdt's paper on the determination of alternating characteristics, and also presented a paper on a new curve tracing instrument.

SATURDAY'S SESSION.

Saturday's meeting was opened with a paper by G. F. Packard on a variable reluctance method of motor speed control. The idea is essentially to vary the flux in the centre of the pole-piece, leaving that at the pole tips of nearly uniform value, thereby varying the speed of the motor without destroying or impairing its ability to commutate without sparking. A plunger of magnetic material is moved and out of the cylindrical field magnet varying the flux in the centre of the pole-piece, but, as stated, not at the pole tips.

Mr. Packard showed excellent results in speed regulation by means of curves for motors of six horse-power and he also stated that an eight-horse-power motor had been built to operate in a similar manner. The voltage of these machines was, respectively, 110 and 220.

Following this paper came those relating to education, the first one being the presidential address of Charles P. Steinmetz, and the others of Dr. Sheldon, Professor Owens, Professor W. Esty, Mr. H. W. Buck and Mr. E. B. Raymond. The essential point in all the papers which were presented on this subject bore on the extent to which the university or college should go in the instruction and preparation of the student for his future work as an electrical engineer. These papers instituted valuable discussion which should be read by all engineers, manufacturers and educators throughout not only this country but all foreign countries as well, and it might be desirable to suggest here that this material be collected as a pamphlet for distribution, through the offices of the Institute, to those young men and those who are responsible for them who desire to investigate the views on the condition of electrical education in this country.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

CONCLUDING SESSIONS AT GREAT BARRINGTON, FRIDAY AND SATURDAY, JUNE 20 AND 21.

FRIDAY'S PROCEEDINGS.

The convention was called to order promptly at nine o'clock by President Steinmetz. The programme as arranged for Friday was carried out in full with the exception of the paper on "A New Photometer for Incandescent Light and Similar Sources," which was withdrawn.

Before adjournment, Professor R. B. Owens, of McGill University, of Montreal, extended a cordial invitation to the Institute to hold its next annual convention in the city of Montreal. Professor Carl Hering offered a resolution to the effect that the British Institution of Electrical Engineers be invited to hold a joint convention at Montreal at the same time.

After some discussion the matter was referred to the executive committee for final action.

Dr. A. Kennelly's report on "Standardization" was read and provoked considerable discussion. Professor Owens called attention to some paragraphs in it which he thought were misleading. Mr. William Stanley, in discussing the general topic, quoted the apt words of the late Franklin Leonard Pope to the effect that, "There were only two kinds of machines, ours and the other fellow's."

It was finally voted to accept Dr. Kennelly's report with the exception of two paragraphs which were referred back to the committee for further action.

Friday afternoon was devoted to a visit to the works of the Stanley Electric Manufacturing Company, at Pittsfield, a special train being provided for the trip. The ladies who accompanied the party were taken around the beautiful little city of 25,000 inhabitants in tally-ho coaches and privileged to enjoy the numerous beautiful views, while the gentlemen were escorted through the old and new works of the Stanley company. A great deal to interest this crowd of experts was found in every department. The visitors were escorted through by Dr. Perrine, president of the company, and Messrs. Noble, Rushmore, Lee, Lillibridge and others associated with the company's interests.

At five o'clock the entire body of visitors, to the number of over 200, met and participated in a very enjoyable lawn tea at the beautiful home of Dr. and Mrs. F. A. C. Perrine. The agreeable host and hostess extended an extremely cordial wel-

come to each individual visitor, and the large quaint old home and very extensive and well-shaded lawns made an ideal spot for this most agreeable reception and entertainment. In the evening the guests were entertained at the Maplewood Inn by Mayor England and the Board of Aldermen of the city of Pittsfield. A band concert was given, a dainty little supper served and dancing provided for those who desired it.

At 10.15 the special train returned to Great Barrington.

SATURDAY'S PROCEEDINGS.

The closing session of this meeting, which was probably the best in the history of the Institute, was begun promptly Saturday morning with President Steinmetz in the chair. The following programme of papers was presented:

17. Opening address upon the general subject, by President Steinmetz.

18. "The Present Status of Electrical Engineering Education in the United States," by Dr. Samuel Sheldon, of the Polytechnic Institute, of Brooklyn, N. Y.

19. "The Equipment of an Electrical Engineering Laboratory," by Professor R. B. Owens, of McGill University, Montreal.

20. "Electrical Engineering Courses at College," by Professor William Esty, Lehigh University, Bethlehem, Pa.

21. "The Education of an Electrical Engineer," by Mr. Harold W. Buck, of Niagara Falls, N. Y.

22. "The Electrical Engineering Courses at College," by Mr. E. B. Raymond, of Schenectady, N. Y.

These papers upon "The Education of an Electrical Engineer" were of the most absorbing interest, and this was equally true of the discussion that lasted up to the close of the convention. The earnestness of the authors of the papers and of the participants in the discussion and on the part of the auditors as manifested by the frequent outbursts of applause was remarkable, doubtless due in some measure to the fact that very diverse views were evidently held by many of those in attendance. Further, also, the professors of electrical engineering present were perhaps put upon their mettle, first, by some reference in the address of President Steinmetz relative to college examinations and incompetent instructors, and, subsequently, during the discussion by Dr. Perrine, who expressed the opinion that no one who had not himself been an electrical engineer was qualified to teach students electrical engineering, and he advocated that for every three or four years that a professor taught he should devote one year to the actual practice of the profession. Dr. Perrine also questioned the utility of a well-equipped electrical engineering laboratory in colleges, saying that for himself, if the money were given to him for such a purpose, he would not know what to do with it. Other speakers thought it was time lost to take up the study of foreign languages, except as literature. There was striking unanimity regarding the necessity for the study of English so that a man should be able to express himself with clearness in writing or in speaking, the man who could not do so being at a decided disadvantage. Dr. Goldsborough, for the professors of electrical engineering, was of the opinion that the attempt to follow Dr. Perrine's suggestion that professors should devote alternate periods of time to the practice of electrical engineering, one to teaching, would empty the colleges of professors, as they would find the actual work so fascinating they would not return to the comparatively irksome and frequently less remunerative work of teaching. He believed, however, that it was the present practice with the majority of professors to investigate personally at every opportunity actual engineering work. He also said in reply to some criticisms not favorable to many of the college graduates, and that might be construed to reflect upon their instructors, that the professors had not the choosing of their students. The boys came to them to be taught and they had to do the best possible to teach them. The teachable students left the school with a very fair degree of knowledge, but knowledge can not be preached into a turnip.

There was no dissension among those present as to the advisability of giving the students a broader general education than they at present receive, even if this should lead to a lengthening of the college course to six or seven years instead of four years as at present. Undoubtedly these papers and the discussion thereupon will have the effect of focussing more general attention upon this exceedingly important question with the result that eventually a system of education will be evolved that will command the approval of a majority, if not all, of those most deeply interested.

NOTES.

On Thursday afternoon a telegram was received from the Pacific Coast Transmission Association, to the effect that Dr. Perrine bring to the notice of the association the vigorous protest which this body makes to the proposed legislation of the Underwriters of the National Electric Association. This was in reference to the proposed new rule for insertion in the National Electric Code in connection with requirements for constant-potential circuits of over 3,500 volts potential, and rule 39 of the existing code.

The proposed new rule reads to the effect that circuits of this potential be not allowed overhead within seventy-five feet of any building. Deviations from this rule can only be made in cases of isolated property or country streets or roads, on application to and written permission of the underwriters having jurisdiction. These lines are also not to be allowed on the same poles with other wires nor on the same side of the street or road with pole lines carrying other wires. It is recommended by the underwriters for lines of over 3,500 volts potential that they be run over a private right of way, and that all poles should be stencilled with the words "Danger — volts." The matter was referred to the committee on National Electric Code. This matter will be taken up by the national board through the National Underwriters' Association at its next meeting in December.

On Saturday morning during the regular session, President Steinmetz and as many officers as could be mustered on this occasion, received the ladies of the Thursday Morning Club. At this time a loving cup was presented to the ladies of this organization in appreciation of the efforts which they had made to make the occasion of the convention a most happy one. President Steinmetz tendered a most eloquent address, and a response was made by Mrs. O. W. Lane for the ladies' organization.

A number of distinguished professors of electrical engineering were present, among whom were Dr. Louis Duncan, Massachusetts Institute of Technology; Arthur E. Kennelly and C. A. Adams, of Harvard University; Dr. George F. Sever and Francis B. Crocker, of Columbia University; Horace T. Eddy, Union College, Schenectady; William Esty, Lehigh University; R. B. Owens, McGill University, Montreal; Samuel Sheldon, Polytechnic Institute, Brooklyn; W. E. Goldsborough, Purdue University, Indiana; E. L. Nichols, Cornell University.

On Saturday, D. Frederick Packard read a paper, not scheduled on the programme, on "A Variable Resistance Method of Motor-Speed Control."

On Saturday afternoon a complimentary dinner was given to the members of the Institute by the proprietors of the Hotel Aspinwall at Lenox. An elaborate menu was thoroughly enjoyed by a large party, the terrific downpour of rain not in any way marring the pleasures of the occasion. Quite a number of the attendants at the convention tarried at Great Barrington until Monday.

LIQUID FUEL—BOILER FIRING WITH OIL—II.*

BY JAMES W. WARREN AND H. T. EDGAR.

STORAGE.

The oil is stored in two steel tanks, each thirty feet long by ten feet in diameter, made of three-sixteenths-inch steel, which are buried in the ground directly behind the plant. These tanks are buried end to end, four feet below the surface, and covered with a four-inch wood logging treated with a wood preserver to prevent the alkali in the soil destroying the tanks. Between the ends of the tanks is a manhole four feet wide by eight feet long, into which all pipes, valves and connections possible are made, affording easy access to make repairs. The tanks are connected together with both the supply and suction pipes and are filled and emptied both at the same time, but the piping is so arranged that it is possible to use each tank separately, affording an opportunity to clean either of them. The oil is delivered in specially-built tank cars, holding from 155 to 300 barrels of oil. A rubber hose three inches in diameter is used to convey the oil from the tank cars to the tanks, and gauges arranged on the back of the plant show the amount of oil in each tank. It takes about forty minutes to unload a car of 6,500 gallons. Each of our tanks will hold about 17,000 gallons, and under the present conditions of operation this will last about half a month, affording us a fair storage capacity.

PUMPS.

There are two 3 by 2 by 3 duplex steam pumps mounted on an iron frame standing about three feet six inches high. These pumps draw the oil from the storage tanks through a one and one-half-inch iron pipe, and discharge it through a one-inch pipe into a small chamber about fourteen inches in diameter by two feet six inches long, placed between and slightly above the pumps. The oil enters this chamber at one end, passing through a partition of very fine wire gauze into the other end of the chamber, where it comes in contact with a heating coil heated with the exhaust steam from the pumps. This runs the temperature of the oil to about 145 degrees Fahrenheit, being the proper temperature at which the oil atomizes freely. The gauze screen or partition is used to strain the oil and keep back sand and dirt, which, if allowed to pass to the burners, would in time stop up the small openings through which the oil passes. The pump being a double one gives us a reserve in case of accident.

BURNERS.

Experiments have been made with two burners, one known as a straight-blow burner and the other known as a cross-blow burner. Thus far we have been unable to see that one burner has any special advantages over the other as regards economy or ease of manipulation. In the straight-blow burner there is a central brass casting with a small bore through which the oil passes. The outside of this casting is fluted like the rifling of a cannon, and outside of this is another brass tube. The steam passing through this space and the fluting, gives it a whirling motion, so that as the oil flows out of the inner bore it is caught by the whirling steam and atomized. It is considerable work to set this burner in place, as there are many changes to make in the brick work of the furnace. In order to atomize the oil thoroughly, the bridge wall of the furnace has to be reconstructed and a sort of grill work of fire brick put in its place. The grate bars are lowered about one foot in the fire box, and a double row of fire brick laid on top in such a manner as to form an air chamber between them through which all air must pass in order to reach the furnace, the idea being that the air becomes heated before coming in contact with the fire. There are two of these burners under each boiler, each one being set in the fire door, and the door bricked up solid, except a small hole for looking into the furnace. When once set up it is rather difficult and expensive to change back to coal.

The cross-blow burner is constructed somewhat differently from the straight-blow burner. It consists of small casting with an overhanging top perforated with small holes arranged in a semi-circle on the under side. Just below these holes is a slot in the burner through which the steam issues in a sheet, and the oil being forced through these holes comes in contact with the steam and is atomized. This burner is put through a hole between the fire doors, using only one burner to a boiler. The grate bars are left in the same position as when coal is used, and are covered with a layer of fire brick laid in mortar. These bricks cover the entire grate except a few inches in front for air, and the bridge wall is left as used for coal. The furnace doors remain unchanged. The principle of an oil burner is that the steam comes in contact with the oil and atomizes and separates it as widely as possible.

To convert a furnace from coal to oil will take from two to three days, and to convert to coal again from two to three minutes, where the cross-blow burners are used. After being once equipped for oil, however, and then converted to coal, it could be reconverted to oil again in about one hour.

In the use of fuel oil it is necessary, in order to get economical burning, to have the oil flow to the burners at a steady pressure. Our first experiments demonstrated the necessity of this, as our fires were often put out through unsteady pressure. With a steady pressure of steam at the burners, if the oil pressure decreases, the steam is likely to blow out the fire, while if it increases, more oil comes through the burners than could be properly atomized, the result being, 1st: The fire smokes badly. 2d: The excess of oil runs away in the ash pit, causing liability to explode. 3d: It fills the tubes with a soot that is much harder to remove than coal soot. 4th: The oil that is not atomized, and flows away, is lost.

In order to ensure a steady pressure of oil it is necessary to provide an auxiliary air chamber. Connected to this air chamber is a small safety valve which, in case the pressure runs above the point required, returns the excess oil to the storage tanks.

To start the burners it is simply necessary to turn on the steam and a small supply of oil, and throw a piece of burning waste into the fire box, and we immediately have a full fire. To regulate it properly it is necessary to adjust the supply of both steam and oil until the fire burns without any smoke; and if properly regulated we get a complete combustion of the oil and avoid almost entirely the presence of soot in the tubes and smoke from the stack. It is also possible, by simply increasing the supply of both steam and oil, to force the boiler to any extent. Care must be taken, however, in selecting burners to get one that thoroughly atomizes and distributes the oil so as not to confine the fire to any one part of the shell and burn the boiler.

The boilers are provided with peep holes in the back to enable the fireman to see the condition of his fire. Care must be taken to watch the fires very closely, and in case they go out for any reason to shut off the oil immediately, as the gas from the oil, combined with the air in certain proportions, is very explosive. Cases of this kind have been known where an explosion has occurred which took the

*Read before the National Electric Light Association at its twenty-fifth convention held at Cincinnati, Ohio, May 20, 21 and 22, 1902.

damper up the chimney and blew out the front of the boiler.

The statement has been made that it takes about four per cent of the steam generated to operate the oil apparatus. We have made no experiments to demonstrate the accuracy of this figure, but our observations go to show that this percentage is large.

In a small plant like this, which is subject at times to a total shut-down, in case the steam of all boilers goes down, it is impossible to start the fire, in which case an auxiliary steam generator must be employed, or the fire brick be removed from the grates and coal be used to get up steam.

In installing this apparatus it is necessary to comply with certain rules and regulations of the insurance companies in order to prevent an increase in insurance rates. These rules, however, are not in any way unreasonable, but are necessary to afford ample protection to the plant. Their principle requirements are:

First—That the storage tanks shall be buried four feet under the ground and ten feet from the building; or, if located more than one hundred feet from the building, may be put above the ground or only partially buried, in which case they must be surrounded by a brick or earth embankment forming a reservoir of sufficient capacity to hold double the contents of the tank.

Second—They must have a gas-tight manhead at the top.

Third—They must not be filled in excess of ninety-eight per cent of their capacity.

Fourth—They must have a two-inch vent pipe.

Fifth—The highest point in storage supply must be at least two feet below the level of the furnace where oil is to be burned, thereby preventing gravity feed to the boilers.

What the saving has been per horsepower or kilowatt-hour as compared with the use of coal, it is impossible for us to tell, as prior to the present ownership of this plant, which changed hands last fall, no records had ever been kept of the kilowatt output or the tons of coal used per month, so that comparisons are impossible to obtain. There is no question, however, but that there is a very large saving in the use of fuel oil. It is claimed by the advocates of fuel oil that four barrels of oil, forty-two gallons to a barrel, are equal to one ton of good bituminous coal.

Experiments have been made by the Water Works Company at El Paso, and some very accurate figures have been obtained. The results of these tests show that the cost of burning fuel oil is exactly half the cost of burning coal, the coal costing $5 per ton, and fuel oil costing seventy cents per barrel. The coal used prior to the installation of fuel oil was San Antonio coal from New Mexico.

A STUDY OF THE HEATING OF RAILWAY MOTORS—II.*

BY A. H. ARMSTRONG.

So far we have considered the question of capacity of our "H" motor for one gear ratio only. It is obvious that similar calculations may be made for any other gear ratio corresponding to a result of several sets of such calculations, it is possible to arrive at a capacity of our "H" motor for any schedule, any gear ratio and any frequency of stops. This may be plotted in terms of any temperature rise, and a set of such curves is plotted in Fig. 10 for a temperature rise of 60 degrees. This set of curves still retains different maximum speed on the level, and by combining the 120 pounds per ton tractive effort, 15-second stops, 150 pounds braking effort, and is based upon the performance of a single car using a four-motor equipment, following the lines of the friction curves given in Fig. 1. The relation between schedule speed and maximum speed on the level is shown with stops varying from one to four miles to four per mile, and the tons per motor for

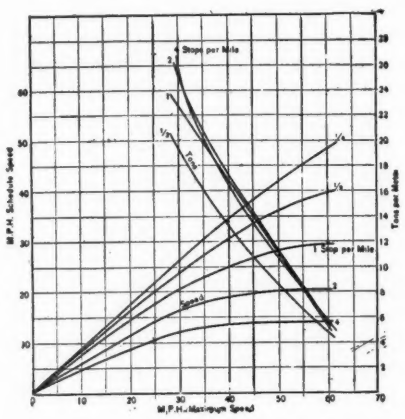


FIG. 10.

a maximum temperature rise in any part of the motor of 60 degrees centigrade are shown from one stop in two miles to four stops per mile.

A careful study of the curves in Fig. 10 gives very interesting results. For instance, the "H" motor geared for 60 m. p. h. can operate between the limits of one stop in two miles and four stops per mile, making a schedule of from 40 m. p. h. down to 14 m. p. h. with approximately five tons per motor in all cases and the same temperature rise. In other words, an equipment of this character is protected from overheating by properly proportioning its gear ratio to the car weight. The possible schedule speed for a given gear ratio is controlled by the number of stops per mile, but the heating of the equipment, with the proper weight of car, will be the same over a very wide range of schedules and stops. The curves, also, bring out very forcibly the importance of properly gearing an equipment for the work which it has to do. For instance, a gearing giving 60 m. p. h. on a level track can make but 20.5 m. p. h. schedule with two stops per mile with a train weight of 5.6 tons per motor, while the same equipment geared for 47.5 m. p. h. can perform 20 m. p. h. schedule (practically the same), but can do so with a total train weight of 12.8 tons per motor, or more than double the train weight possible for the same temperature rise with the 60 m. p. h. equipment. In other words, the equipment should be geared for the lowest possible maximum speed that will permit the maintenance of the schedule in question, as a gear ratio giving too high a maximum speed for the work to be done not only overheats the motors, but produces needless demands upon the generating and distribution systems.

The curves in Fig. 10 give a fairly complete study of the type "H" motor when applied to the operation of single cars equipped with four motors. All points in the curve except for a maximum speed of 30 m. p. h. are obtained with the operation of single cars, and as our friction curves may be inaccurate, being based upon a single set of tests, or trains of more than one car may be run, it is instructive to reproduce a similar set of curves for two, three, four cars, etc., per train. The motor capacity for a given temperature rise is governed largely by the shape of the friction curve used at high speeds, especially for the longer runs, and in Fig. 11 is shown a comparison between the operation of one and two-car trains making the same schedule, and using the same accelerating tractive effort per ton, braking and stop intervals as in Fig. 10. This set of curves is also plotted for a temperature rise of 60 degrees centigrade, but it is obvious that from the foregoing material we could plot similar curves for any other temperature rise. As the curves showing the relation between tons per motor and maximum speed for a given temperature rise come so close together for the different frequency of stops, this sheet has considered only the relation between tons per motor and maximum speed for one stop per mile. Thus we see that at 60 m. p. h. the type "H" motor operating a single car has capacity of but 5.3 tons per motor for 60 degrees rise, while if two cars are coupled together

* A paper presented at the nineteenth annual convention of the American Institute of Electrical Engineers, Great Barrington, Mass., June 19, 1902.

and operated as a single train, the reduction in wind friction per ton of train weight increases the capacity per motor to 7.5 tons for the same 60 degrees temperature rise, an increase of 42 per cent. This opens up a new field of enquiry as to whether it is commercially advisable to run single car units at this high speed when the motive power, and as it will be shown later on, the energy input are both larger than would result from operating the same seating capacity in trains of two cars or more, with a correspondingly increased time interval between trains. In other words, is the electric traction idea of small units at frequent intervals a proper method of attacking the very high speed electric traction problem, or are we compelled to go back to the steam method of operating heavier trains at more infrequent intervals in order to prevent a prohibitive investment in motors, and generating and distributing systems, and a ruinous expense for operation? It is true that the electric system, being eminently adapted to subdivision, has created the demand for travel by means of its frequent service, where none previously existed, but it may be possible that for very high-speed work too great a price may be paid for the privilege of operating very frequent small units.

The foregoing discussion has described a method of determining the probable heating of a given motor when operated under any known conditions. The results obtained are so complete and give such a mass of working data directly applicable to service requirements that the labor of the detailed calculations necessary seem amply justified. Specifications of stationary apparatus are prepared in careful detail and acceptance tests carried out in great exactness, but the tendency to slight the railway motor problem, owing largely to its seeming complexity, is hardly warranted, when it is considered that the capital invested in such apparatus may be double that required for generator power to drive it. Then, too, the generator is carefully housed, provided with an attendant and otherwise taken care of, while the motor is exposed to outside climatic conditions and only gives evidence of being overloaded by burning out. The selection of such apparatus should receive the most careful attention, the proposed service conditions fully worked out and the proper size of motor and correct gearing chosen to ensure a reasonably small expense for maintenance.

The present method of rating railway motors is to determine the current which they will carry at 500 volts on a stand test giving a temperature rise of 75 degrees centigrade in the hottest part after sixty minutes' run. In other words, the one-hour rating of railway motors gives only an indication of the comparative capacity of two motors in actual service, and affords no data to serve as the basis of calculating the service capacity of the motor. It does determine the mechanical qualities of the motor, as the one-hour test is generally very severe, and it also affords a means of observing commutation at the maximum current for which the motor will probably be called upon in service operation. Some method of rating railway motors which would give an accurate comparison of their service capacity under different conditions, if such a rating is possible, would be of great advantage over the present very general one-hour rating.

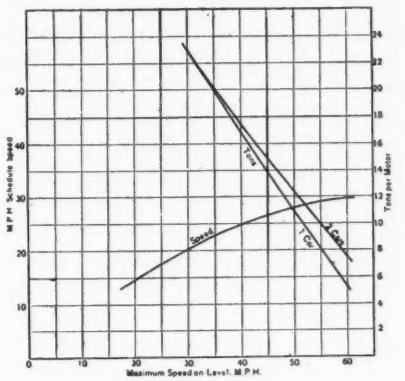


FIG. 11.

The foregoing investigation has pointed out the very variable nature of the work which a railway motor has to do, and the different relations between service performed, distribution of the losses and the ultimate heating of the motor. In Fig. 3 the various motor losses are shown for the type "H" motor, taken as an example, but it is evident that different motor loss curves, even for the same service performed, could not be compared directly with any assurance of arriving at their comparative temperature rise. Proceeding further, we come to the values given in Fig. 6, showing the relation between motor losses, their distribution and the resulting temperature rise per watt loss. Similar curves of different motors could be compared directly and give some means of their relative capacity, but here, also, there is no direct comparison as different motors do not have the same efficiency, and therefore will not give the same loss for the same service performed. In other words, given two motors having the same thermal constants, that is, the same degrees rise per watt loss, the motor having the poorer efficiency will rise to a higher temperature for the same service performed, owing to its greater loss. We can not, therefore, look to the thermal curves as giving the comparative rating needed.

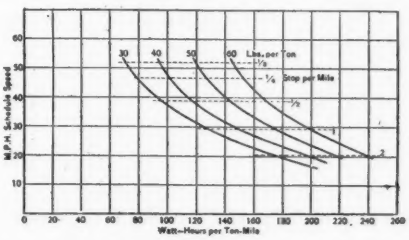


FIG. 12.

In Fig. 7 we have a fairly complete history of the type "H" motor operating under a given set of assumptions. These assumptions are those pertaining to service operation, and such a set of curves for another motor calculated for the same conditions would give accurately the comparative size, or, in other words, the comparative temperature of the two motors for the same service performed. In Fig. 7 the "service capacity curves" approach much nearer to a basis of comparing different motors, but as a method of rating railway motors it is incomplete. In the first place, we have assumed a given rate of acceleration, while it is obvious that the demands of different classes of service, especially low-speed service, will call for different rates of acceleration, and hence a separate sheet would have to be made out for every rate of acceleration. The effect of increasing the rate of acceleration and increasing the time of coasting is shown in Fig. 9, giving such discrepancy between tons per motor for a given temperature as to make sheets similar to Fig. 7 entirely unreliable for comparing different motors, especially when the maximum speeds are low and the acceleration energy is the determining factor in the motor heating.

There is another variable, the rate of braking, which has not been entered into in this discussion, and which also affects the heating of the motor, especially on low-speed high-acceleration problems. On the higher speed problems, where friction is the ruling factor, it is found that we must also assume a certain friction rate, or, in fact, a friction curve plotted to a definite formula in order to arrive at consistent results with different motors. Having once determined on this friction curve for a single car, our calculations are immediately disqualified when we couple two of these same cars together and perform the same service, the friction rates at speeds of 50 or 60 m. p. h. falling off considerably as we approach a train composed of several units.

In addition to the foregoing variables, we have the element of the energy consumed by the rotating parts during acceleration. This factor is practically negligible at very high speeds, but figures very prominently in acceleration problems with low speeds. In giving the rating of a railway motor, it will be necessary, therefore, to fix definitely upon the weight and centre of gyration of car-wheels and armatures, and furthermore determine the effect of the motor parts for a given gear ratio.

After all these variables are definitely fixed, we must repeat the same set of conditions for each motor gear ratio, or, as a more general case, for each different maximum speed on level, thus eliminating the question of the total number of teeth in gear and pinion. It is not intended in any way to discourage an effort to rate a railway motor by some method that will give its comparative capacity, but it is well to canvass carefully the large field of variables which must enter into such a rating, and to have clearly in mind the bearing which these different variables have in determining the temperature of the motor. It is evident that by affixing certain values to accelerating rate, train friction, braking effort, energy of rotating parts, etc., it will be possible to prepare a set of curves giving the relation between schedule, frequency of stops and temperature rise for any car weight, which would give accurately the comparative size of a railway motor in relation to any other motor for which curves were similarly plotted. Such work is being done by the General Electric Company on its standard railway motors, and, in fact, is necessary in order to be able to give the probable performance of a motor under any set of conditions, and follow through the effect of changing conditions. The method, however, is cumbersome, and has so many factors entering into the case that it probably may never serve as a commercial rating; furthermore, such relation could only be expressed by curves, or a long, tabulated statement, and neither method is short and concise enough for a commercial rating.

As the result of considerable investigation along these lines, the writer has not arrived at any commercial rating of a railway motor which serves its purpose better than the one-hour test now universally used. Admitting that such a test does not give the comparative size of different motors, it does serve the purpose of largely determining its commutating qualities and possesses the advantage of being commercial. Unless a rating can be proposed which will indicate accurately the relative size of motors, the present method of one-hour rating possesses advantages which would hardly warrant its being superseded.

Although insufficient data is at hand from the foregoing calculations to form the basis of a complete treatise on the subject of train energy, sufficient material is provided to furnish some very interesting comparisons. As the basis of calculations, we assume the operation of single car trains composed of 25, 35 and 45-ton cars, geared for a maximum speed of 60 m. p. h. for the 35-ton car. From our friction curves we find that these three cars at 60 m. p. h. require a tractive effort of 59 pounds, 50 pounds and 43.5 pounds per ton, respectively. The same calculations were carried through for trains composed of two cars or more, the cars being of different weights, so that we are able to plot a set of curves showing the relation between schedule speed and watt-hours per ton mile input to the train, virtually ignoring any fixed formula for train friction. Such a set of curves is shown in Fig. 12, being plotted for 30, 40, 50 and 60 pounds per ton friction rate of 60 m. p. h. These curves may be regarded as fairly general in their scope, except that they follow the general form of the friction curves given in Fig. 1. In other words, we can get from these curves in Fig. 12 the energy consumption for any friction rate at 60 m. p. h., the error introduced by assuming a general shape of curve being very small.

An inspection of Fig. 12 brings out forcibly the fact that the subject of car energy at high speed is most intimately interlinked with the question of train friction. As the schedule speed decreases with the increasing number of stops, or in other words, as the energy of acceleration becomes a more important factor, the per cent difference between the energy values for different train frictions becomes less, as would be expected.

The electric road has almost universally used one-car units, and as it has branched out into suburban high-speed work, the advantages of more frequent service have made the operators of such roads retain the single-car idea. From the curves given in Fig. 12, some figures can be secured of what it costs to operate a single car, and also trains of two or more cars, where the maximum speed is 60 m. p. h., and the stops very infrequent; that is, the more advanced type of our private right-of-way suburban road. A single 35-ton car having a friction, say, of 50 pounds per ton at 60 m. p. h., will consume 119 watt-hours per ton mile at a schedule of 52 m. p. h. with one stop in eight miles. Let two such cars be coupled together in a train, reducing the friction to 33.5 pounds per ton, and the train will require an input of only 78 watt-hours per ton mile, or 65.5 per cent of the energy rate per ton required in single-car operation. In other words, single cars on thirty-minute headway would require 52.5 per cent more energy for their operation than would two-car trains on one-hour headway. With five-car trains composed of 35-ton cars, the energy is reduced to 56 watt-hours per ton mile for the same schedule, or less than half what will be required per ton for the operation of single-car trains.

From a purely energy standpoint it would seem that the operation of single-car trains was disadvantageous, but experience has shown that it is not fair to assume that two cars operated every hour will attract the same custom as one car operated every thirty minutes. In other words, the frequency of service creates travel, and in many cases warrants the extra expenditure for coal. There is another aspect of the case to be considered and that is that with two-car trains at more infrequent intervals the load upon the feeding points is more fluctuating, the size of rotary converters must be somewhat increased, and in all probability a larger amount of feeder copper will be required to keep the drop within the same limits. Although a saving may be effected in the coal pile by increasing the train headway and giving the same seating capacity in trains of two or more cars, there is every reason to expect a call for a greater expenditure of money to install the road, and an increase in interest and maintenance account that may go far toward eating up the saving in the fuel expense.

In Fig. 13 and 14 are given curves showing the relation between schedule speed and train energy for maximum speeds of 45 and 30 m. p. h., respectively. It will be noticed that, particularly for 30 m. p. h. maximum speed, the train friction becomes a very much smaller factor in determining the energy input, especially as the number of stops per mile increases.

All these three sets of curves are plotted for an accelerating rate, corresponding to 120 pounds per ton, and a braking effort of 150 pounds per ton. The values given will, therefore, be subject to considerable variation for different accelerating and braking efforts where the schedule speed

is low and stops numerous. The curves are, however, of fairly general use, especially for runs of a mile or more, as the effect of rate of acceleration and braking is not so marked on longer runs.

In Figs. 12, 13 and 14 is considered, also, a period of coasting equaling 10 per cent of the time the train is in motion. While this is a fairly general assumption and will give sufficient margin for a large majority of problems, it will be found in carrying out the subject to a conclusion that the per cent of coasting is a very large factor in determining the train energy input. For instance, a high rate of acceleration with a long period of coasting will demand less energy input to the train than a lower rate and little or no coasting. The reason for this is obviously that the efficiency of acceleration of the two runs may be approximately 70 per cent, while the speed at which brakes are applied is less with a longer coasting period, and hence the work demanded by the equipment is less.

In all three of the energy curves given, a variable friction during acceleration and coasting is considered, but straight-line braking is assumed. The energy required to accelerate the rotating parts is also considered, so that the curves as given are of fairly general application.

In this paper the writer has attempted to outline a method of determining the probable heating and energy consumption of a given equipment for any class of work, having in mind also the possibility of arriving at some short, concise method of rating different railway motors, so that their comparative service capacity might be accurately indicated. As the subject of motor capacity is so dependent upon experimental tests, not only of car friction and braking, but also of heat radiation under working conditions, the conclusions drawn were based as far as possible upon actual experiments made. Were it not for the fact that car friction, or, rather, train friction, is such a variable quantity, dependent not only upon the condition of track, but upon the speed and composition of the train, it would be possible to plot a set of curves for a given friction and distance, and apply these curves for similar shaped runs over greater or less distances by taking the coordinates proportional to the square root of the area of the speed time curves; that is, proportional to the square root of the distances covered. As, however, the wind friction at the higher speeds changes the value of friction per ton to such an extent, it is only possible to draw up curves for a given set of conditions and generalize, as is done in Figs. 12, 13 and 14, for different friction rates.

While it is thus possible to prepare a set of energy curves which are of fairly general application to all problems, it is only feasible to express the relation between motors of different capacity by a series of curves similar to those described in Figs. 7, 8, 9 and 10. It is entirely possible to approximate the probable heating of motors of different sizes when the resistance, core loss and general construction is known, but such short-cut methods are,

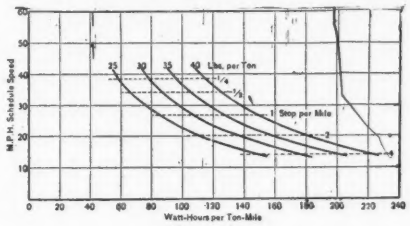


FIG. 13.

at best, only approximations and no true comparison of different motors can be made which will take into account their different losses for the same work performed and their capacity for radiating these losses at different speeds, without considering the subject in detail for each motor alone along the general lines indicated in this paper.

In dealing with the railway motor where the temperatures approximate 60 degrees centigrade rise in practice, with an air temperature in summer reaching 30 to 35 degrees centigrade, we have not much

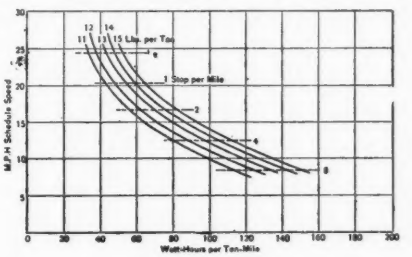


FIG. 14.

leeway below a temperature injurious to the insulation, and approximate methods giving rise to errors of 10 or 20 degrees centigrade in temperature can not be seriously considered in such important calculations as the determination of railway motor temperature. For this reason the methods outlined, although entailing a large amount of experimental work and subsequent calculations, provide an accurate method of determining the temperature of railway motors operating under any known conditions, and, although they fail to provide a method of rating railway motors, it is due to the fact that such a method of rating can not be expressed by any short term, but necessitates some such general curves as are indicated in the paper.

The writer wishes to acknowledge the services of Mr. E. F. Gould in preparing material for this paper, and the kindness of the General Electric Company in furnishing results of experimental tests which served as a basis of all calculations.

THE FUNCTION OF SHUNT AND SERIES RESISTANCE IN LIGHTNING ARRESTERS.*

BY PERCY H. THOMAS.

INTRODUCTORY.

In a paper read before this Institute on February 14 of the present year, the writer treated the subject of static disturbances in high-tension lines and discussed some types of protective apparatus—chiefly the choke coil, the static interrupter and the multi-gap lightning arrester. The function of the choke coil or interrupter was described as the prevention of local concentration of potential in windings of transformers or generators, such as is caused by waves of static electricity; the function of the lightning arrester, to prevent an excessive rise of potential of the protected circuit above the earth. The lightning arrester has also a secondary function of great importance, namely, the suppression of the arc which tends to follow a simultaneous discharge to ground from two legs of a circuit. The object of the present paper is the description of a new method of enabling an arrester to suppress such an arc, which is, of course, backed by the power of the generating system. This principle not being directly involved in the question of the protection of apparatus from static strains received but bare mention in the paper referred to above.

The type of arrester about to be described involves the use of series and shunt resistance in connection with a multi-gap arrester. This type is important, as it permits the use of a very low series resistance with the arrester, giving a comparatively free discharge path to earth. That is, the chief advantage of the arrester using series and shunt resistance over that using only series, is the fact that the former may be made operative with a much smaller series resistance than the latter.

Some years ago, Mr. Henry Noël Potter discovered, in some investigations on lightning arresters for Mr. Wurts, that a voltmeter connected in multiple to some Wurts non-arcing metal alternating-current arresters prevented the formation of a permanent arc in the gaps. In this experiment a highly inductive circuit was being used, such as had been found very severe on the non-arcing power of these arresters. Investigation then developed the fact that the shunt path formed by the voltmeter was the cause of the sup-

* A paper presented at the nineteenth annual convention of the American Institute of Electrical Engineers, Great Barrington, Mass., June 18th to 21st, 1902.

pression of the arc. Mr. Potter later made practical application of his discovery in the large generator switches at the power-house of the Niagara Falls Power Company. In these switches several breaks in series are introduced, some of which are shunted by resistance.

At a later date, Mr. Charles F. Scott proposed the use of this principle for the improvement of lightning arresters. Trial proved, however, that a great deal more was involved in the application of the principle of a shunt resistance to lightning arresters than to the large switches at Niagara, and it was found necessary to investigate the subject from the beginning. This work, which was carried out by the writer, developed some very interesting laws or principles, which will be fully discussed. The final result has been the design of a new type of commercial arrester, which includes not only a shunt resistance, but a series resistance as well. This arrester, which is adapted to alternating-current circuits only, is called the low equivalent alternating-current arrester on account of its low spark-gap equivalent.

PRINCIPLE OF OPERATION.

The complete lightning arrester embodying the shunting principles is shown in Fig. 1, and consists of a number of small air-gaps connected between line and ground, a portion of these gaps being shunted by resistance, marked "shunt resistance," and a series resistance placed in the earth connection. The shunt resistance is usually placed, as shown, next the series resistance, and preferably half of the total number of gaps are shunted.

It is evident that when the arrester is not in action, the point P at the junction of the shunted and series gaps is at ground potential, and consequently that the arrester will discharge whenever the voltage of the point M of the line reaches a potential above the ground sufficient to cause the series gaps to break down; that is, the voltage on the line necessary to cause the arrester to discharge is that required to break down the series gaps alone, regardless of the presence of the shunted gaps. This has a very important bearing on the protective power of the arrester.

During actual discharge the operation of the arrester is as follows:

When the series gaps break down, the resistance between the points M and P is momentarily reduced to practically zero, and the full amount of the potential of the line is then thrown on the shunt and series resistances. If this potential, which is thus abruptly applied to the resistances, is high, the shunted gaps will be broken down. This makes, for the instant, a direct path for the static discharge from line to series resistance. Theory and experiment both show that practically no greater voltage, provided it be suddenly applied, is required to break down both series and shunted gaps than the series gap alone. This result is due to the fact that the two sets of gaps are broken down separately, one after the other. If conditions are right, current from the generator will then follow the static discharge through the gaps, establishing an arc. The current will flow through the shunt and series resistances and usually through the shunted gaps, but if the various parts are properly proportioned, the shunt resistance will take enough current from the shunted gaps so that the arc can not hold in the latter and will drop out. Once the arc drops out in the shunted gaps, it must pass through both resistances, which will reduce the current strength and enable the series gaps to suppress it altogether.

The series resistance is found necessary for the successful operation of the arrester as outlined above, to prevent the enormous rush of current, which, on circuits of large generating capacity, would otherwise follow discharges and cause lights to dip and synchronous apparatus to fall out of step, as well as overheating the arresters themselves. This series resistance through which the discharge must pass is evidently in general an objectionable feature in the arrester, although it will be practically harmless if its amount is not too great. By the use of the shunt resistance the value of the series resistance is kept comparatively small. This is the chief advantage of this type of arrester. A fuller description of the effect of the series resistance on the discharge of the line will be found in the paper to which reference has been made above.

CONDITIONS AFFECTING NON-ARCING POWER.

The capacity of an arrester to suppress or prevent the formation of an arc in its gaps after discharge may be called its "non-arcing" power, and an arrester which is able to accomplish this result under all conditions for which it is designed may be properly called "a non-arcing arrester." It is evident that an arrester will never be non-arcing when connected to a circuit whose normal electro-motive force is high enough to cause the arrester to discharge. The non-arcing power of a combination of gaps and resistance under a given set of conditions will here be measured by stating the number of gaps required, under these conditions, to be just able to suppress the arc. The conditions determining the proper proportioning of parts in an arrester using shunt and series resistance may now be considered. Before taking up the subject of the shunting power of resistance it will be necessary to outline the conditions covering the non-arcing power of a simple series of gaps with or without resistance in series, which is found actually to be the fundamental case.

NON-ARCING POWER OF AN UNSHUNTED SERIES OF AIR-GAPS.

The use of a number of small air-gaps in series in an arrester rather than one large gap is an essential feature in all arresters for high-voltage circuits. The conditions affecting the non-arcing power of such a series of gaps are of two sorts. First, those involved in the physical and chemical construction of the gaps themselves, and second, those depending upon the constants of the circuit to which the gaps are connected. The conditions in the first class being quite generally recognized will be only briefly mentioned.

1. Non-Arcing Metal—There is a surprising difference in the non-arcing power of gaps of the same form but of different material, even when tested under the same conditions. This very important fact was discovered by Mr. Wurts some years ago and has been fully described by him. Those metals which give the greatest non-arcing power—commonly called non-arcing metals—are zinc, bismuth, antimony, cadmium and mercury. The presence of zinc in an alloy will usually give this alloy a non-arcing quality. Copper, tin and iron are not suitable for lightning arrester work. The condition in which the terminal is left by a momentary arc, that is, whether it is pitted or whether it is beaded, so that the gap is partly bridged over by the melted material, varies markedly with different materials. This point is a very important consideration. Iron has a tendency to bridge the gap, while non-arcing alloy pits slightly, leaving the gap virtually in as good condition as before the occurrence of the arc. In choosing his non-arcing alloy, Mr. Wurts used such proportions of zinc and copper that the effect of the zinc which pits is just balanced by that of the copper which beads.

2. Multi-Gap Principle—The fact that a series of gaps is a much more powerful non-arcing device than a single gap which requires the same voltage to start a discharge, is probably due partly to the chemical or electrolytic actions occurring at the surface of the terminals, and partly to the cooling effect of the metallic termi-

nals, which in the small gaps are so close to the arc. When the arc is suppressed by the gaps of an arrester, the current drops out as it passes through its zero value and the air rapidly regains its insulating quality, so that when the electromotive force is reversed and the current tends to build up in the opposite direction, the arc is suppressed, since the gap has lost its conducting power. The remarkable speed with which incandescent air can become cool is shown by the fact that very rapidly moving objects viewed by the light of a static spark passing through air appear stationary. This means that while the air has become incandescent and has cooled again, the moving body has not changed its position sensibly.

3. Length of Gap—With gaps between one-sixty-fourth of an inch and one-sixteenth of an inch, the non-arcing power varies, somewhat less than proportionally to the length of the individual gaps.

4. Minor Conditions—The temperature of the terminals of the gaps is quite an important condition, as a great increase of temperature reduces the non-arcing power of the gaps. The non-arcing power of the so-called "non-arcing" alloy falls off materially after very long continued hard service. This is probably because the zinc is gradually burned out.

Those conditions affecting the non-arcing power of a series of gaps which depend on the constants of the circuit to which the gaps are connected, may be called the "circuit conditions." The "circuit" must include all apparatus actually connected to the system. Circuit conditions are, chiefly, the voltage of the generator, the capacity of the system to deliver current on short-circuit through the gaps, the equivalent inductance through which such current flows, the frequency of the system, and the phase of the generator electro-motive force at which the discharge starts.

The following laws have been experimentally determined with gaps of non-arcing alloy, each approximately one-thirty-second of an inch, and do not necessarily apply to other conditions without modification.

1. Generator Voltage—With the total power and the power-factor of the circuit as a whole, constant, the number of gaps necessary to suppress an arc is somewhere nearly proportional to the voltage of the generator. This number of gaps, however, does not increase quite as rapidly as the voltage. That is, if we place the gap across the terminals of a raising transformer supplied by a generator and then connect the secondary coils of the transformer in various symmetrical combinations, so as to give different voltages (in all cases using the whole of the transformer winding), under these conditions the number of gaps required is

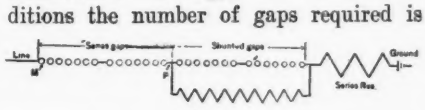


Fig. 1.

approximately proportional to these transformer voltages. If, however, the strength of the current following a discharge or the inductance of the circuit is kept constant as the voltage varies, the number of gaps is by no means proportional to the voltage of the circuit.

It is interesting to note that the number of gaps required to withhold the generator voltage and prevent its breaking down the gaps without the aid of a static discharge, obeys an entirely different law from the number required to suppress the arc after a discharge. The number of

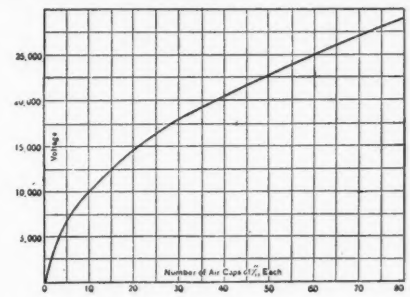


Fig. 2.

gaps required to hold the given voltage under one particular set of conditions is shown in Fig. 2. This is to be compared with a straight line, which shows approximately for different voltages the gaps required to suppress an arc when once started.

2. Short-Circuit Current—The voltage, inductance, etc., remaining unchanged, the non-arcing power is proportional to a power of the short-circuit current between the first and the second, usually more

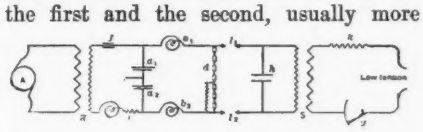


Fig. 3.

nearly following the second. This law is not unexpected, assuming the cause of the holding of the arc in the gaps to be the heat generated, since the amount of this heat is proportional to the square of the current and to the resistance, the resistance, of course, decreasing with an increase of current. With large current and high power-factor, the non-arcing power is more nearly proportional to the first power of the current, but with small current at low power-factor it follows the second power quite closely.

This law is a most important one as regards commercial lightning arresters, since the growth in the power of central stations means large currents flowing on short-circuit, which, in return, requires many gaps, and since the minimum practical gap is soon reached, an excessive equivalent gap between line and ground will result. As long as plants were only very moderate in capacity, the multi-gap arrester without resistance was perfectly adequate for all cases, but with the very large installations of the present time this is no longer true, and with such systems, some resistance should be used to increase the non-arcing power.

In determining the short-circuit current that will flow through the arrester after a static discharge, not only the capacity of the generator itself to deliver current on short-circuit must be considered, but also that of all synchronous apparatus, storage batteries and even induction motors, under some circumstances. With two generators in parallel, more gaps are required than with a simple generator. If a resistance be placed in series with the air-gaps, the amount of current flowing after a discharge will be reduced and fewer gaps will be non-arcing. This resistance has much the same effect, so far as the gaps are concerned, as reducing the capacity of the generators.

3. Inductance—With a given current and a given voltage, non-arcing power varies inversely as the inductance in circuit. This law is only approximate. With large amounts of inductance, the non-arcing power does not fall as fast as the induction increases.

This is a most important condition for the inductance of a generating system varies inversely as its power, other things being kept in proportion, so that as far as this condition alone is concerned, the large generator produces an easier condition for the gaps than a small one, since the inductance is less. On the other hand, the large generator will give a larger short-circuit current, which affects non-arcing power more nearly as the square, consequently the total result of increasing the capacity on the system is to reduce the non-arcing power of a given series of gaps.

The effect of the inductance in the circuit may be considered as a function of the energy stored electromagnetically. This energy is equal to $\frac{1}{2} I^2 L$. When this stored energy is large, the wave form of the electro-motive force in the gaps is

flattened so as to give a very short period for the small values of the current near the zero point of the wave. This, of course, reduces the opportunity for the cooling of the hot gases of the arc. In some cases there may even be an increased voltage above the normal, due to the stored energy, although this rise will never be of serious moment, as even a small increase of normal potential will merely cause the gaps to continue to discharge. Experiment shows the effect of a given quantity of stored energy to be less effective in reducing non-arcing power on low voltage and large currents than on high voltages and small currents. This difference is quite marked.

The effect of inductance in the circuit is very noticeable to the eye and ear. When the inductance is large, the arc in the gap is much quieter but more persistent, and may continue as long as one second and then drop out. This delay in the suppression of the arc probably represents the period necessary to consume the energy stored in the magnetic field by the initial rush of current following the static discharge. This original discharge, having a very high current density, reduces the resistance in the gaps to practically zero, and for several alternations thereafter this resistance is probably increasing period by period.

It is very difficult to compare the non-arcing power of similar gaps on different voltages, for of two circuits having the same power-factor, one running at double the voltage of the other, that having the higher voltage will have an inductance and resistance four times as great as the other. To have the same stored energy in both cases, the first circuit must have half the current of the second, but half the current means a different heating effect, so that the conditions of the two cases as regards current are not comparable. Of the two circuits of different voltages, that of the higher is more difficult to control, as far as its inductance is concerned, but on the other hand, if the total power of the generating apparatus be the same in the two cases, it will have a small current which means less heat in the arc.

For a circuit of given voltage, it is readily seen that the addition of inductance to a non-inductive circuit containing a series of air-gaps, such as is under discussion, has the effect, if the inductance be comparatively small, of increasing the severity of the conditions on the gaps, for although the current is slightly reduced, yet the stored energy as a whole is increased considerably on account of the great percentage of increase of the inductance, but as more inductance is added the current is more and more rapidly decreased, so that, although the inductance still increases a point is finally reached at which the stored energy, which depends on the square of the current, will be as a whole decreased by the addition of further inductance. When this point is reached, further increase of inductance renders the conditions on the gaps easier.

4. Frequency—The frequency, at least between twenty-five and sixty cycles, is not very important in its effect on non-arcing power. The length of a single alternation is, of course, longer with the lower frequency, so that more heat units are produced by a given current before the zero point of the current arrives, but the time of duration of the period of small current also lasts longer with the lower alternations, giving a compensating effect. The stored energy, of course, does not depend on the frequency. Experiment shows that if anything the lower alternations are the more severe on the lightning arrester.

5. Phase of Electro-Motive Force at Time of Discharge—The phase of the electro-motive-force wave of the generator at the instant of static discharge is an extremely important condition, for when the discharge occurs with the generator electro-motive force nearly zero no arc will be formed in the gaps with any condition of inductance or capacity of generator. There is, therefore, a certain portion of each alternation in which a discharge will be unable to start an arc; just how large a proportion of the alternation this will be depends upon the non-arcing power of the gaps. In a successful arrester this period must include the whole alternation. If discharges are passed at random without relation to the phase of the generator electro-motive force in making tests of non-arcing power it will be found that 25 to 50 or even 100 trials must be made to be certain of producing the severest condition. For this reason there will be a great variation in the apparent severity of the discharges of arresters of this type on actual lines, for lightning occurs at random, at different phases of the generator electro-motive force, causing a greater or less tendency of the arc to follow; this will naturally cause a larger or smaller flash in the gaps.

The chief conditions upon which the non-arcing power of a given series of air-gaps depends have been considered, and the powers and limitations of the arrangement pretty well outlined. It is evident that for very large plants the number of gaps necessary to secure satisfactory non-arcing power will render the protective power of the arrester inadequate. This difficulty may be overcome by the use of series and shunt resistance in the manner already described.

SHUNT RESISTANCE.

The effect of adding a resistance to shunt a portion of such a series of gaps as has just been discussed will next be considered. If the addition of this shunt resistance is to better the conditions as regards suppressing the arc, then the proportion of parts must be such that without the shunt resistance the full number of gaps in the arrangement considered will fail to be non-arcing. In what follows, it will be assumed that the static discharge occurs at the phase most favorable for the continuance of the arc in the gaps. It will be readily seen that after the passage of the static spark the current which will flow through the shunted gaps, will, on account of their resistance, produce a certain amount of voltage across the shunt resistance, which must, therefore, take a certain amount of current. This current will evidently be subtracted from the current in the shunt gaps. The decrease in the latter current increases the resistance in the shunted gaps, which throws more current into the shunt resistance, and so on. If, now, the current in the shunted gaps is only just sufficient to maintain an arc when no shunt resistance is present, then the subtraction of a portion of this current will cause the arc to drop out in the shunted gaps. This forces all the generator current to flow through the shunt resistance. All current, of course, flows through the series gaps and the series resistance. With the arc suppressed in the shunted gaps, the shunt resistance will then reduce the strength of the current in the series gaps, and, if it be great enough, will render them non-arcing. The laws determining when the shunt resistance will be able to withdraw sufficient current to cause the arc to drop out in the shunted gaps have been determined as follows, the shunting power being measured by the greatest number of ohms per shunted gap allowable in the shunt resistance:

1. Number of Shunted Gaps—The amount of resistance which will allow the shunted gaps to be non-arcing is proportional to the number of these gaps.

2. Short-Circuit Current—The number of ohms allowable per shunted gap is proportional approximately to the square of the current which flows through the shunted gaps immediately following the static discharge. The "ohms per gap admissible" do not fall, however, quite as

fast as the square of the current increases, so that doubling the current does not reduce the ohms per gap to quite one-quarter of its previous value.

3. Power-Factor—The ohms per gap depend, to a slight extent, upon the power-factor of the current following the discharge through the shunted gaps, being greater with low power-factors. This is a fortunate circumstance, as circuits with low power-factors are the most severe on arresters, and the ability to use a large shunt resistance allows the current and stored energy to be very materially cut down as soon as the arc drops out in the shunted gaps, which renders the series gaps more easily non-arcing.

4. Ratio of Series to Shunted Gaps—One very unexpected result is discovered, *viz.*, that the ohms per shunted gap depend largely on the ratio between the number of the series and shunted gaps. If the series gaps greatly exceed the shunted in number, the shunting power of the shunt resistance is much reduced, and *vice versa* if the shunted gaps exceed the series gaps the shunting power is increased. The objection to using more shunted gaps than series gaps is that a reduction in the protective power in the arrester will result, since more voltage will be required to break down the shunted gaps and discharge the line than is required to break down the series gaps.

5. Frequency—The frequency has little effect in the shunting power between twenty-five and sixty cycles; if anything the lower alternations are the more severe. It is fortunate that non-arcing power is nearly independent of frequency, as standard arresters may be designed for use upon circuits independent of frequency.

METHOD OF DESIGN OF ARRESTER.

With the above outline of the laws governing the shunting power of resistance, it is now possible to outline a method of designing an arrester which will be perfectly non-arcing under any conditions assumed. First, determine the current given on short-circuit by the system. In doing this, the following factors must be considered.

a. Generator Field Reaction—As this is roughly proportional to the current, its effect will be the same as a resistance in series with the circuit and its equivalent ohms may be determined from the characteristics of the generator.

b. Inductance and Resistance—The true inductance of the armature which must be separated from the field reaction, the effect of all synchronous apparatus, which for the moment will act as a generator, the resistance and inductance of the line, transformers and auxiliary apparatus must be determined. When all these characteristics are together considered the approximate short-circuit current and the stored energy may be approximated.

A number of gaps which is able to withhold the maximum normal line voltage with a suitable margin must then be chosen. If this number of gaps, unaided by resistance, is able to suppress the short-circuit current with the given amount of stored energy, the arrester may be considered complete. If such a series of gaps is not non-arcing with the given conditions, the number of gaps should be doubled and one-half of them shunted by resistance and a series resistance added. The total amount of resistance must be such as so to cut down the short-circuit current, that the series gaps will be non-arcing with the actual stored energy of the system. The largest possible portion of this resistance should be shunted, consistent with the ohms per shunted gap being sufficiently low to have the shunt effective. The remaining part of the resistance will constitute the series resistance. It may thus be seen that the use of series and shunt resistance may be made to give the freest practicable discharge path for a given set of conditions, with the multi-gap type of arrester, and at the same time be non-arcing under all the given conditions.

METHOD OF INVESTIGATION.

A brief description will be given of the method of making the experiments from which the laws stated in this paper were determined. Tests have been made on a number of different generators, and at a number of different voltages. In each case the diagram of circuits was in effect like Fig. 3, except that in some cases raising transformers were omitted.

A is the generator supplying current to the gaps; R the raising transformer sometimes used to obtain the required voltage on the gaps. At D are the gaps to be tested; C and R are either inductance or resistance, or both, placed in the main circuit to control the short-circuit current or the stored energy. B_1 B_2 are small choke coils in main circuit. A_1 and A_2 condensers to ground. A_1, B_1, and A_2, B_2, form two single-pole static interrupters to protect the raising transformer from the static strains produced in sending sparks over the gaps. F is a fuse used to open the main circuit when the gaps fail to interrupt the arc. This fuse, which usually consisted of one or more strands of No. 23 German silver wire, in a long tube, was found to open the circuit easily under the worst conditions tried.

To obtain the exciting static spark, a high-tension transformer is used at S, with a ratio suitable for breaking down two gaps, L_1 and L_2, which are so adjusted that the discharge of the condenser H, resulting from their breakdown, was sufficient to force a discharge across the gaps at D. A resistance was used in series with the low-tension winding of this transformer to prevent any current from flowing from S through the gaps, etc., other than the charge of the condenser. The circuit of this transformer is closed on the low-tension side whenever a spark is desired by a swing switch with a long arm making momentary contact at G.

The apparatus was so adjusted that for each swing of the switch a clear, single, purely static spark crossed the gaps at D.

In making the tests, a great many combinations of inductance and resistance were used, and in each combination several numbers of gaps, and with each number of gaps from twenty-five to fifty sparks were passed, so that the phase of the wave most favorable for the arc's holding was practically certain to be tried.

This sort of testing is very laborious, very slow and involves considerable risk to apparatus, and the results when obtained will always vary quite widely, even under apparently the same conditions—as would be expected from the nature of the phenomena. Therefore, it must not be expected that the relations that have been described will hold with anything like the accuracy of many electrical relations. They should be considered rather general laws from which individual tests will vary in one direction or the other, more or less, on account of ever-changing secondary conditions.

In the use of series resistance in lightning arresters, there is a great temptation to limit the short conduit current to an unsafe degree, as this reduces very much the difficulty of constructing a non-arcing arrester. Prevention of an arc is in itself a comparatively easy matter, but to secure good protection at the same time, the short-circuit and the arc through the gaps can not be strictly prevented but must be allowed to occur and then be suppressed. This is the difficult problem. The use of shunt and series resistance furnishes a means of reducing very materially the obstacle offered by series resistance to perfectly free discharge. Any further steps in the same direction should be welcomed.

A METHOD OF COMPOUNDING ALTERNATING-CURRENT GENERATORS AND MOTORS, DIRECT-CURRENT GENERATORS, SYNCHRONOUS MOTOR-GENERATORS AND SYNCHRONOUS CONVERTERS.*

BY FRANK GEORGE BAUM.

The weakest element in the regulation of an alternating-current system is usually the generator. Makers of engine and water-wheel governors are able to keep the variations in speed in the machines which they send out much lower than builders of alternating-current generators are able to keep the variations in voltage. The time is past when the man who is selling a generator points with pride to the fact that the machine may be short-circuited with little increase over nominal current. The argument that compounding of alternating-current generators is not necessary because load changes are not rapid, does not hold, as the fluctuation of voltage of ten per cent or more in some stations testifies. Working an alternating-current station without compounding is equivalent to operating a direct-current station with shunt-wound generators. When induction motors are to be operated, as is usually the case, the conditions are worse. No electrical engineer would install shunt-wound direct-current generators, even if the load changes are not rapid, and the only reason for not installing compounded generators is that there is at present no method by which the compounding may be produced for large stations. There are methods of compounding single machines which are more or less successful, but no method, I believe, for large stations, which gives results that can be compared with those obtained by compounding direct-current generators.

The following method of compounding alternating-current generators for any load and any power-factor, so that we get results equal to those obtained by compounding direct-current generators will, I believe, commend itself to electrical engineers. In some respects, the method is simpler than in the case of direct-current generators, as will be shown.

Fig. 1 shows the connections of the "compensator," as it may be called. G is the generator, which, for the purpose of explanation, may be considered a two-pole machine. From its shaft is driven the armature $a\,a'$, having field poles A A'. The armature winding may be considered a single turn of wire, as shown. One end of the armature wire goes to a solid ring and the other end to a ring broken, as shown, but the two parts are metallically connected. It is to be noticed particularly that there is no commutation, the same armature wire being always connected to the same brush. Brushes are placed on these rings, as shown, the brush on the broken ring being in the centre of one pole. The metallic segments of the broken ring cover about ninety electrical degrees.

If the field A A′ were excited by a

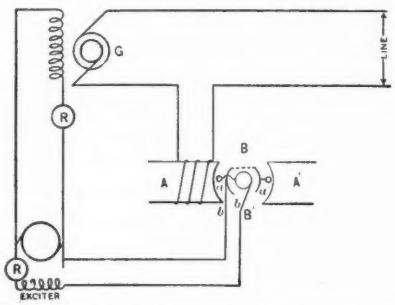
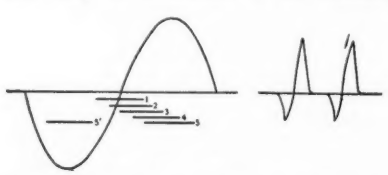


FIG. 1.—SHOWING POSSIBLE CONNECTIONS OF COMPENSATOR.

direct current we would get at the brushes, parts of an alternating wave, a part of each wave being cut out owing to the fact that the ring is divided. If we excite A A′ by a sinusoidal alternating current in synchronism with the rotation of the armature $a\,a'$, we get waves of electromotive force at the brushes of different forms, depending on the position of the armature coil when the current passes through its maximum value. For example, if the armature coil passes the position shown when the current in the field coil is a maximum, it will be evident that we get a rectified potential at the brushes $b\,b$. We really cut off the top of the wave and thus get a potential at $b\,b$ which may be measured by an ordinary



FIGS. 2 AND 3.—SHOWING METHOD OF OBTAINING A RECTIFIED POTENTIAL, AND TRACE OF OSCILLOGRAPH RECORD FOR SECOND POSITION.

direct-current voltmeter. If the current in the field passes through zero when the armature coil passes the position shown, then we get no rectified potential.

What really occurs for the different positions may be explained with reference to Fig. 2. The sine wave is the wave of current from the alternator, and may also represent the wave of magnetism in the compensator poles A A′. The lines 1, 2, etc., represent the metallic segments for different positions of the armature coil with respect to the wave of magnetism. If the current is passing through zero when the coil is in the position shown in Fig. 1, then we cut off the part of the wave under the line 1, and hence get an alternating potential. There will also be an alternating electro-motive force due to the transformer action, but no account need be taken of this. Now, suppose the current lags behind this position. This is equivalent to a motion ahead of the metallic segment with respect to the wave of current. For the position 2 of the metallic segment, we would cut off that part of the wave under the line 2. Fig. 3 shows a trace of the electro-motive-force wave for the second position in Fig. 2. This record was taken with a Blondel band oscillograph. As the current lags more and more, we pass through the positions 1, 2, 3, 4 to 5, for a lag of ninety degrees, which gives us maximum rectified potential. If the current leads, there is a relative motion between the wave of magnetism and the metallic segment in the opposite direction. For ninety degrees lead we get the position 5′, giving us a reading equal and opposite to that obtained for the position 5.

Fig. 4 shows a curve between the voltage read by a direct-current voltmeter across $b\,b$ and the angle of lag of current (the zero angle does not correspond to a non-inductive current run from the generator, but corresponds to the position 1 of the metallic segment in Fig. 2), the current in the field of the compensator being constant. The form of the rectified voltage curve may be changed very easily by varying the arc of metallic segment. It will be seen that the curve in Fig. 4 is very similar to that shown in Fig. 5, which shows the regulation of a generator delivering constant current, but at different power-factors. By the regulation is meant the percentage by which the generated pressure must exceed the terminal pressure. We get this same kind of a curve for the regulation of a transmission line. If it were possible, now, to add to the excitation of the generator, amounts proportional to the ordinates in Fig. 5, we would obtain a generator which would regulate on any load and any power-factor from ninety degrees lead to ninety degrees lag. The field poles A A′ may be rotated with respect to the armature so that when the alternator is working on a constant load, the different voltages across $b\,b$, shown by the curve in Fig. 4, may be obtained. Now, we set the poles A A′ with respect to the poles of the alternator, when the alternator is working on a non-inductive load, to correspond

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about to position 2 for the metallic segment in Fig. 2. That is, we work approximately as many degrees to the right of the zero point in Fig. 4 as the current lags through the generator. This point may be easily found with a direct-current voltmeter across *b b*, as we merely rotate the field until a certain fraction of the maximum voltage is obtained. This setting takes but a moment and may be made while the alternator and compensator are running.

This voltage, now, may be added to the alternator in several ways. If, then, the current delivered lags behind the terminal pressure of the generator, the potential added will increase according to the curve in Fig. 4. If the current leads, the voltage added will decrease, pass through zero and then increase in the negative direction.

The rectified potential may be added in series with the exciter field, as shown in Fig. 1. This method gives very good results. It is found that loads of any character may be added to the machine without disturbing the voltage. The generator may also be over-compounded to maintain constant potential at some point on the line.

There are some objections, however, to this arrangement, because it is not "fool proof." The arrangement shown diagrammatically in Fig. 6 has therefore been adopted. As shown, the rectified potential is used to excite a small direct-current generator of 100 to 500 watts capacity, and the armature of the direct-current machine connected in series with the series winding on the exciter. The direct current is large, so that only a few turns are needed on the exciter. These may be easily threaded on by hand, if there is not already a series winding on the exciter, so that no new exciter is needed. The percentage compounding may be changed simply by turning the rheostat handle in the armature circuit of the compensator. The compensator has four poles and is driven in synchronism by a gearing on the generator shaft. Fig. 7 shows the general arrangement of the compensator. The compensator set being small, it is a simple matter to add the compensator to any generator.

This method may be applied to compounding alternators operating in parallel, whether the generators have separate exciters or are all excited from the same exciter. When there is a separate exciter for each machine, the compensator may be applied to each generator, or a single compensator may be put on one generator and the current from the direct-current side carried around each exciter field. The station would then, of course, be compounded only when the generator to which the compensator was connected were running. The entire station may be compounded by a single compensator set where all generators are excited from the same exciter. In this case, the current for the field of compensator would be taken from the bus-bars.

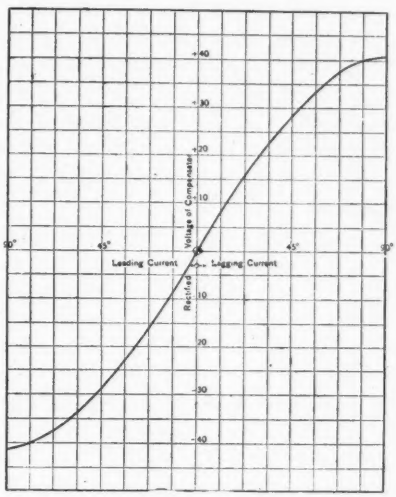


FIG. 4.—CURVE OF RECTIFIED VOLTAGE OF COMPENSATOR, WITH CONSTANT FIELD CURRENT AND VARIABLE ANGLE.

Since we must supply only a fraction of the exciting energy of the exciter, the compensator set of 500 watts capacity is large enough to compound a 10,000-kilowatt station.

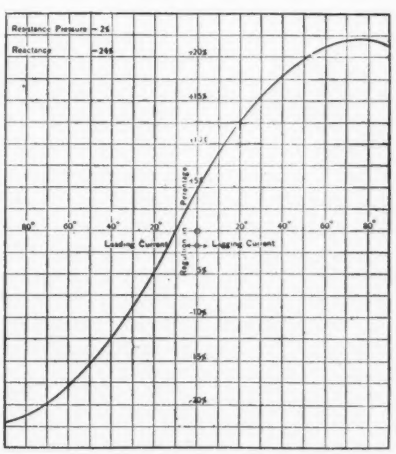


FIG. 5.—REGULATION OF GENERATOR ON CONSTANT ARMATURE CURRENT AND VARIABLE POWER-FACTOR.

It will be seen that this method of compounding is in some respects simpler than the present method of compounding direct-current machines. The following are some of its advantages:

1. Generators have a single winding.
2. No equalizer bus-bars, switches, etc., are necessary.
3. No adjustment of low-resistance shunts is necessary to make machines take their proper share of load.
4. When the generators are over-compounded, there is no drop in voltage when a fresh machine is added.
5. Percentage compounding may be changed instantly by turning a rheostat handle.
6. The cost of compounding a large station will be less than compounding the same number and capacity of direct-current generators.
7. Owing to the absence of equalizer switches, the operation of the station is simpler.

COMPOUNDING SYNCHRONOUS MOTORS.

At the present time there is no method of compounding the excitation of synchronous motors other than those driving direct-current generators. The method given for compounding alternating-current generators may be used to compound the excitation of alternating-current motors. This removes one serious objection to the use of synchronous motors on transmission lines for other purposes than for operating direct-current machines.

COMPOUNDING DIRECT-CURRENT GENERATORS.

The method given for compounding alternating-current generators is comparable with the method of compounding direct-current generators shown in Fig. 8. Here we excite all the direct-current generators by one exciter and compound this exciter with the load current from the generators. This does away with the series winding on each machine, as well as all equalizer connections and switches. We are not bothered with the troublesome problem of adjusting a number of low-resistance shunts in such a way that all machines will take their proper share of load. Except for the addition of the exciter, the operation of the station is very much simplified. To provide against the possibility of an injury to the exciter and the consequent disabling of the entire station, the generator fields should be provided with double-throw switches, so that in case of injury to the exciter the generators could be temporarily operated as shunt-wound machines. Shunts 1, 2, 3, etc., with switches, may be put on the exciter series field, so that the compounding may be made to suit the number of generators running, or to vary the compounding when desired. When the generators are over-compounded, there will not be a drop of line potential when a fresh machine is added, as is the case in the method of compounding each generator. Where there are a number of

large generators in a station, this method of compounding seems to be cheaper and simpler in nearly every way than that commonly used.

COMPOUNDING SYNCHRONOUS MOTOR-GENERATORS AND SYNCHRONOUS CONVERTERS.

The above mention of compounding the exciter has been very successfully used to

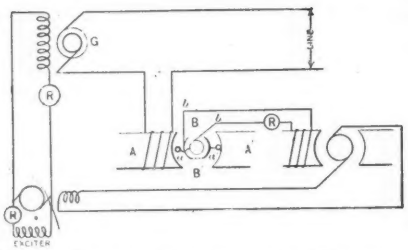


FIG. 6.—SHOWING CONNECTIONS OF COMPENSATOR USED IN PRACTICE.

compound the excitation of three motor-generator sets operating on a street railway load at the end of a 150-mile transmission line. The arrangement is shown in Fig. 9 for a single set. All the synchronous motors were, of course, excited from the same exciter. No new exciter was needed, as the motors were already excited by a compound-wound exciter. All that was necessary to apply the method was to shunt part of the current from the direct-current side around the exciter series coil. This varies the excitation of the motor so that changes of load have little effect on the line potential at the motor terminals. Before the synchronous motors were compounded, lights could not be operated on account of the excessive variations of potential.

Since a separate exciter is generally used for this kind of work, this method is very much cheaper and simpler than carrying a series winding around the field poles of each motor. This method may

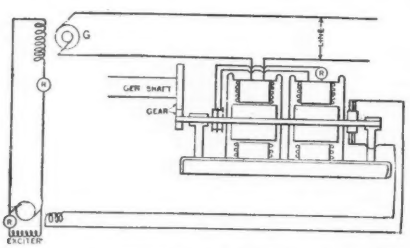


FIG. 7.—COMPOUNDING GENERATOR OR SYNCHRONOUS MOTOR.

also be applied to compounding synchronous converters.

COMPOUNDING TRANSMISSION SYSTEMS.

In applying these methods of compounding to the most general case of a transmission system with a long trunk line with several branch lines, the generators would be compounded for the centre of distribution and the synchronous motors on each branch line compounded also with respect to the centre of distribution.

It is well known that poor regulation is usually the besetting sin of many long-distance transmission systems, and very often the only solution of the problem of getting rid of a large percentage of the power generated is to restrict the motion of the recording voltmeter needles so as to impress possible customers more favorably. Systems are in operation where there is a variation in voltage of ten per cent, and very often when synchronous motors operating on the line get to surging, owing to the bad regulation, there will be a drop or rise of perhaps twenty per cent. Such a system for a mixed load of lights and power must in the end be displaced by something better. On long-distance transmission systems, where the generator capacity is large compared with the load changes which are likely to occur, the pressure at the power-house may remain fairly constant and yet vary ten per cent at the receiver.

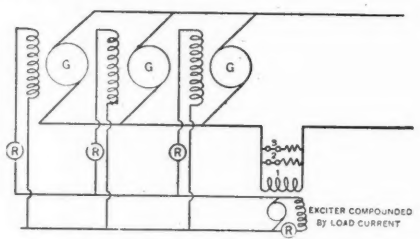


FIG. 8.—COMPOUNDING DIRECT-CURRENT GENERATORS.

Fig. 10 and Fig. 11 bring out in a striking way the effect of changes of load and especially of changes of power-factor on the regulation of the line. Fig. 10 represents a fifteen-mile, 60 p. p. s., three-phase transmission system, with 10,000 volts between neutral and line wire. The power transmitted is 3,000 kilowatts at full load, with a copper loss of eight per cent, including step-up and step-down transformers. *o a* is the receiver pressure, the point O not being shown. The pressure consumed over the line by the power component of current is measured along *a c* and the pressure consumed by the wattless current is measured at right angles to *a c*, to the right of *a c* for lagging currents, to the left for leading, *a c*, which represents full load, has been divided into ten equal parts, corresponding to .1, .2, etc., of full load. Through points marked .1, .2, etc., lines have been drawn at right angles to *a c*. Radial lines making angles corresponding to $\cos\theta = .95$, $\cos\theta = .9$, etc., for lagging and leading currents, have been drawn from *a*. Circular arcs, with the point *a* as centre, have also been drawn through points along *a c* marked .1, .2, etc. The regulation for any load and any power-factor may be determined from the figure. For example, find the regulation at .9 full load at .8 power-factor: Go along *a c* to $c' = .9$, then along $c'\,g'$ to the intersection with the line $\cos\theta = .8$. The regulation is seen to be about twenty-one and one-half

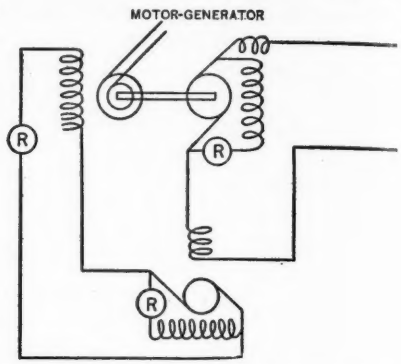


FIG. 9.—COMPOUNDING MOTOR-GENERATOR EXCITER, COMPOUNDED BY LOAD CURRENT.

per cent. For .9 full-load current, and the same power-factor, the regulation is seventeen per cent, as shown by the point *h*.

Fig. 11 shows the regulation of a 150-mile, 60 p. p. s., three-phase transmission system with 30,000 volts between neutral and outside. The power transmitted is 9,000 kilowatts, with a line loss of ten per cent, including step-up and step-down transformers. The triangle *k l a* shows the rise in pressure over the line due to the charging current. The regulation of the line for any load and any power-factor is shown.

As an example, find E *o* for 0.8 load at 0.725 power-factor. Follow *a c* to point *c''* (marked .8), then follow *c'' g''* to point of intersection of *c'' g''* with line marked $\cos\theta = 0.725$. The point is on the circle 12,200. This is the value of E *o* (twenty-two per cent above E). Lagging current assumed in example for leading current E *o* is given by *p t* g_2.)

An intelligent application of the methods here given will, it is believed, even in

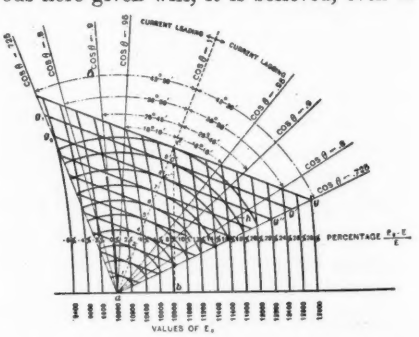


FIG. 10.—REGULATION OF TRANSMISSION SYSTEM.

the worst case, give us a system with very satisfactory regulation.

I wish to thank Mr. Frank Adams, superintendent of the Stockton Gas and Electric Company, for allowing me the privilege of making the preliminary tests on the compensator in the company's station.

Stanford University, Cal., April, 1902.

Annual Convention of the Association of Railway Telegraph Superintendents.

Eighty-five delegates representing the chief railroads of the country and coming, East, from New York, Boston, Philadelphia and Baltimore, to Denver, West, gathered at the Stratford Hotel, Chicago, from June 18 to June 20. While the association is now in its twentieth year, this is the first occasion since it was founded in Chicago that the annual meeting has been held in this city.

The extent to which the telephone is taking the place of the telegraph instrument in railway service was the main subject of discussion. Already train orders are being handled by telephone on several of the roads.

The first business done was the election of officers. J. H. Jacoby, Lehigh Valley, is the new president; W. J. Holton, Chicago and Western Indiana, vice-president, and P. W. Drew, of the Wisconsin Central, succeeds himself as secretary and treasurer.

Mr. W. J. Holton read a paper on "The Use of Typewriters for Taking Train Orders," followed by general discussion.

Thursday morning Mr. Benson Bidwell, of Grand Rapids, Mich., to whom is given credit for perfecting the means of telegraphing and telephoning from moving trains, presented a paper, entitled "Telephones and the Telegraph," dealing very thoroughly with the subject. Mr. Bidwell contended that while it was possible to establish telephone and telegraph connections from a moving trolley car, no such a system had yet been found practicable on the ordinary railroad. Therefore, he made the suggestion that communication with moving trains could be made if a trolley wire or third rail were placed alongside the tracks. The discussion that followed was a lively one, several of the members claiming that if practicable and generally adopted, there would be a revolution in telephony and telegraphy which as a discovery would only take second place to wireless telegraphy as employed on the Atlantic liners. Various plans for solving the problem were talked over, and finally President J. H. Jacoby was given authority to appoint a committee to make a test.

On the closing day of the meeting Mr. B. C. Green, of St. Paul, superintendent telegraph department of North Pacific, gave an elaborate explanation of his system of using simultaneously telegraph wires for telephone purposes. This was followed by considerable discussion.

Mr. J. J. Nate, of the Stromberg-Carlson Company, Chicago, manufacturer of telephone apparatus, gave a short address on "The Increased Use of Telephones by the Railroads," accentuating the act that the telephone operator had far greater opportunity to demonstrate his abilities than the telegraph operator, and consequently better chance of promotion.

To the executive committee was left the choice of next meeting place, but it appears to be understood that the annual convention of the Railway Telegraph Superintendents will take place at New Orleans in May, 1903.

By the invitation of the Stromberg-Carlson Company a number of the delegates visited the establishment on Jackson Boulevard. Messrs. Nate and Knight took the visitors all through the plant and all were pleasantly entertained. Later the committee Chairman Jacoby had been authorized to appoint the preceding day in connection with Mr. Bidwell's suggested plan made a practical test with a moving train at Kensington from the main offices of the Illinois Central Railroad. It was in every way successful and a fitting close to a very successful convention.

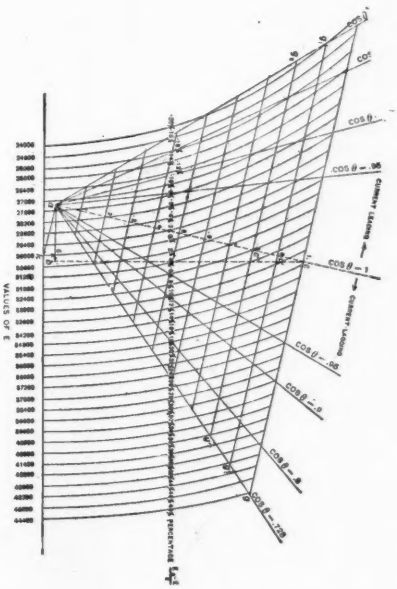


FIG. 11.—REGULATION OF 150-MILE TRANSMISSION LINE.

The Irregularity Factor on Engines.

The modern electrical industry makes heavy demands on engines intended for alternating driving, this more particularly for reference to governing and a certain minimum of irregularity without which, according to present ideas, a satisfactory supply can not be maintained. The irregularity of the engines introduces a highly disturbing element into the plant, and the electrician is inclined to suggest that the irregularity is not within the specification, while the engine builder endeavors to prove by calculation that the machine entirely complies with the requirements. Every engine in which a reciprocating motion is converted into a rotary one shows, as is well known, on account of the differences of perpendicular pressure, an irregular rotary motion, and in consequence of this, even when the engine is running at a perfectly constant number of revolutions, shows varying angular velocities within a single revolution. These usually repeat themselves in the same way periodically every revolution. These variations usually arise without anything having altered in the governor or fittings of the machine. The cause of this is partly to be looked for in the irregularity of the engine itself, through which parts capable of getting up a swing, like flywheels with flexible shafts and spiders in combination with the elastic volume of steam in the cylinders are set into resonant vibration, and as these will usually coincide with other periodic times, a combined motion is produced.—*The Electrical Review* (London), May 30.

The American Electrochemical Society.

The American Electrochemical Society will hold its second general meeting at Niagara Falls, N. Y., beginning Monday, September 15, and extending to Wednesday, September 17, and possibly to September 18. The local committee will provide interesting excursions and exhibits of the local electrochemical industries which will be an important feature of the meeting. A number of excellent papers are already promised, and the prospects are that the meeting will be even more successful than the splendidly attended inaugural meeting at Philadelphia. Entertainment will be provided for ladies, and it is expected that quite a number will attend. The secretary is desirous of issuing the programme not later than August 15, and to this end those members who wish to contribute papers at this meeting are urged to notify him at the earliest possible moment.

With Pleasure.

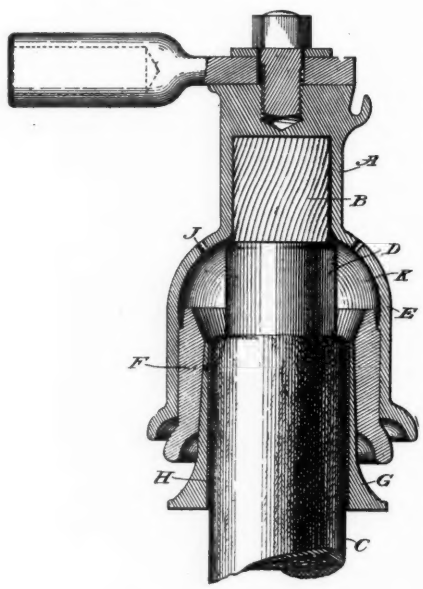
TO THE EDITOR OF THE ELECTRICAL REVIEW:

It is with pleasure that I send you my check for the ELECTRICAL REVIEW for this year.

CHARLES H. WATERMAN.

Electrical Patents

Mr. Ernest Gonzenbach, of Wheaton, Ill., has just patented a novel cable terminal. The object of the invention is to provide a construction of cable terminals which is simple and efficient and wherein leakage of the current is efficiently guarded against. The illustration is a longitudinal section of a cable-terminal construction embodying the principles of the invention. Heretofore the difficulty of efficiently insulating the ends of cable or other conductors carrying heavy currents in order to prevent leakage of current has given rise to much trouble in the practical use of such cables or conductors. This is especially true in the case of lead-covered cables or conductors. Leakage of current invariably causes electrolytic action of the lead, gradually wearing through and exposing the paper or rubber or other insulating covering of the cable. This is a difficulty which has been encountered in practice to an annoying extent even on cables having their ends or terminals in covered or unexposed places, and in the case of cables which are required to terminate in the open it has been almost impossible to overcome this trouble. It is the special purpose of the present invention to provide a construction of cable terminal wherein in a most simple and efficient manner the difficulties noted are avoided. In the accompanying drawing, illustrating a construction embodying a practical application of the invention, A designates a casting of bronze or other suitable material arranged in substantially a bell shape and provided with an interior pocket adapted to receive therein the exposed end B of the cable or other conductor, the internal diameter of the recess of casting A being just sufficient to enable the exposed end B of the cable or conductor to be received therein. C designates the lead covering which encases or encloses the insulating covering D, surrounding the cable. The end of the lead sheathing or covering C extends into the bell-shaped portion E of the casting A. An insulating bushing F is interposed between the exterior surface of the lead casing or sheathing C and the interior surface of the bell-shaped portion E of the casting, and an exteriorly tapered sleeve G is interposed or driven in between the insulating bushing and the lead cable covering or sheathing. If desired, a sheet of fibre (H) may be interposed between the tapered sleeve G and the lead sheathing or casing. This, however, is immaterial and unimportant and, if desired, may be omitted. The casting A is provided with suitable openings J, through which insulating material may be poured into the cavity K. The wedge or tapered sleeve G may be of wood, bronze or other suitable material. In assembling the parts the casting A is heated. The exposed end B of the cable is then inserted into its seat in the casing and soldered or otherwise fixed therein, if desired or necessary, and while the casting A is still warm. The insulating bushing F is then slipped into place, and the tapered sleeve G, either with or without the fibre lining H, is then driven tightly into place between the bushing and the covering or sheathing of the cable. In cooling, the casting A will shrink over the parts thus assembled, thereby forming a tight and compact joint. The cavity K is then filled with a suitable

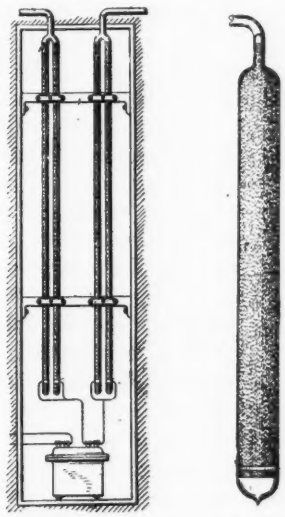


Novel Cable Terminal.

insulating compound of any desirable kind through the holes J provided for that purpose. The construction above described provides a most simple and efficient cable terminal, in which provision is made against possibility of leakage of current and consequent electrolytic action.

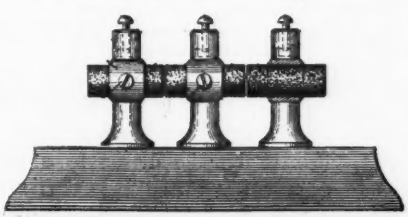
Mr. Daniel McFarlan Moore, of Newark, N. J., has invented a novel electric lighting system, involving as one of the constituents thereof light produced by means of electric energy supplied to the terminals of a gaseous column or body contained in a translucent receptacle. The object of the invention is to avoid the use of electric conductors for distributing the electrical energy to the lamps or light-giving portions of the system, and to thereby permit the illumination of buildings and contained areas without the presence of conducting wires or circuits of copper distributed through the building or the rooms. Briefly stated, the invention may be said to consist in distributing or running a translucent tube or receptacle over the areas, spaces or rooms to be lighted, the terminals of the tube being brought to the source of energy outside of the areas or spaces or in a location where the terminals may be suitably protected against danger of contact or accidental interference, the tube containing a gas which is of such character or degree or rarefaction that by the application of electric energy or current to the terminals of the tube it will be rendered luminous by the transfer of the energy from one terminal or electrode to the other. In the practical installation of the system the translucent tube of glass could be built up *in situ* in the position it is to occupy while in use, or could otherwise be distributed as a tube of glass over the spaces to be illuminated, and its terminals, which are provided with the suitable energy transferring electrodes or caps, would be brought to a protecting cabinet or wall pocket in which they would be connected to the two poles of the energy-supplying devices, which latter might be mains or wires leading direct from the primary generator of electromotive force or might be terminals of a suitable transformer adapted to give the required voltage at its secondary. In practice, and for the preferred form or character of the lamp alternating electric currents of greater or less voltage are utilized as found desirable. For illuminating the interior of a dwelling or structure the portions of the glass tubing which contain the luminous column from which the effective illumination is obtained could be distributed in any desired way throughout the whole interior of the dwelling or structure, as one or more tubes with the conducting caps or terminals thereof brought from within the illuminated spaces or areas to an exterior cabinet or receptacle, where its conducting caps would be located out of harm's way and in immediate connection with the source of energy, or, if desired, the energy might be carried into the building and suitable transforming devices located in sealed wall pockets within the same, the terminals of the tube being located in the same manner in the pocket, while the luminous portion of the tube would extend over or through the areas to be lighted, being distributed in any desired form or manner therethrough. While the invention may be carried out with any form of

lamp having the characteristics above described—to wit, a translucent receptacle and energy-supplying electrodes at the terminals or near the terminals of the luminous columns—it is preferable to use for the purpose a form of lamp previously devised by the inventor and consisting, essentially, of a translucent tube whose conducting terminals or electrodes are caps or sheets of graphite attached closely to the exterior of the tube and transferring their energy by electrostatic action to the contents of the tube itself. Among the advantages attained by this system of electric lighting are the following: First, the complete absence of fire risk, even when the lamp is operated by high voltages, since it is not necessary to have any metallic conductors within the areas or spaces where danger from fire may exist; second, great economy in installation and in efficiency or consumption of power, owing to the fact that the number of electric fixtures required for holding and supplying energy to the terminals of the tube is reduced to a minimum, thus decreasing the cost for fixtures alone, also to the fact that the proportion of cap to length of luminous column is very greatly reduced. The advantages of the invention so far as concerns the latter feature will be obvious from the following consideration: In tube-lighting as heretofore practised by tubes have been employed, which at a maximum would be, say, from seven to eight feet long, that being the largest size which could be manufactured, manipulated and installed with convenience. With the tubes of such length and employed in sufficient numbers to illuminate a space of any considerable size a large number of fixtures would be employed, and moreover, the conducting cap placed upon the tube, if of length sufficient to transfer the proper amount of energy and to secure the desired density of light, would very largely obscure the actual light-giving column, so that almost half of the total length of the tube might be non-luminous. Moreover, the case of lamps having exterior conducting caps or terminals the total resistance of the lamp is made up of two elements, namely, the resistance at the caps and the resistance of the gas itself. The resistance at the caps is very large and prevents the tubes from having a high efficiency, because this resistance is non-luminous. In the present invention this element of resistance becomes a factor of less importance, because a greater value is given to the other factor, namely, the resistance of the luminous column, which is the efficient energy-consuming portion of the lamp, because it produces the light. Mr. Moore has obtained several patents on this system and also on the various elements going to make up the same. One of these patents covers the lamp *per se*. The tubes as first constructed, had conducting caps or terminals on their ends that were made of carbon or metal and completely surrounded these ends. These caps being opaque, completely shut off the emission of light, and in this respect were objectionable. He has improved the construction, however, by forming the caps so that they extend only partially around the tubing, thus leaving the opposite portions of clear glass. Further than this, the carbon served to absorb a considerable portion of the light, and this objection is also overcome by interposing a reflecting surface between the same and the glass wall. The reflecting surface is formed of a mixture of zinc sulphite and zinc carbonate mixed with water and silicate of soda. It is painted upon the glass, and after being thoroughly dried the carbon is placed upon the same in the form of paste. The reason for employing the above mixture is that it will not discolor with heat, and at the same time will adhere to the glass.



NOVEL SYSTEM OF ELECTRIC LIGHTING.

The American Electric Telephone Company, of Chicago, Ill., has purchased a patent on a novel form of lightning arrester invented by Mr. Ernest E. Yaxley, also of Chicago, the device being especially designed for use in protecting the instruments of a subscriber's telephone set. A suitable base block is employed, upon the upper face of which are mounted three standards having on their upper ends binding-posts, the outer binding-posts receiving the line wire, and the intermediate post being grounded. These posts have at intermediate portions, collars, the openings through which are in alignment, and in these collars are arranged carbon pencil sections that are also aligned. The sections are placed with their ends spaced a slight distance apart and are held in position by means of suitable set screws passing through the collars. In the normal operation of a telephone apparatus the currents on the line wire pass from the incoming binding-post through the instrument to the outgoing binding-post, as the air-spaces between the carbon sections present a relatively higher resistance than the resistance of the instrument itself. When, however, a disruptive lightning discharge of an extremely high potential encroaches upon the line it tends to seek the nearest ground, and therefore passes from the line and binding-post into one of the carbon sections and disruptively discharges from the line carbon section to the carbon section held in the ground binding-post, and from thence to the ground or earth. When metal is employed, the tendency of the repeated disruptive discharges is to form papillæ between the presented metal ends of the arrester, and thus establish a permanent path between the sections and short-circuit the telephone instrument. In the improved form of arrester by employing carbon sections, which is relatively a highly refractory material, this tendency to form a short-circuiting path is diminished, and should the short-circuiting path form between the ends of the carbon sections it is evident that the air-spaces may be restored by conveniently cleaning the presented end surfaces of the carbon sections. This may be done by means of paper or any other substance inserted between the carbon ends. Further, it often becomes necessary during the continuance of a severe electrical storm to establish a permanent short-circuiting path to earth between the two binding-posts of the instrument, thus short-circuiting the instrument and taking it entirely out of the telephone circuit. This may readily be accomplished with the apparatus by loosening the set screws and pressing the two outer carbon sections intimately into contact with the intermediate ground carbon section and then setting up the set screws, rigidly holding the outer sections in such intimate contact.



NOVEL FORM OF LIGHTNING ARRESTER.

Reviews of Current Engineering and Scientific Literature.

Giving Concisely the Substance of Important Papers in the Scientific, Electrical and Engineering Press of the World.

Some Notes on Polyphase Machinery.

In this paper the author presents some notes bearing on the construction and operation of polyphase machinery of standard types, a discussion of the latest developments in this branch of electrical engineering, such as the compounding of generators and the question of synchronous generators, and other special machinery. At the same time an endeavor has been made to render the paper interesting by giving full structural details of certain modern plants of standard design with which the author is acquainted.—*Engineering* (London), June 6.

A Selenium Telautograph.

A new instrument for the reproduction of images at a distance has been devised and tested by A. Korn. This is based upon the sensitiveness of vacuum discharges at an exhaustion of 0.2 to 2 millimetres to slight changes in the resistance of the circuit, and the external photochemical activity of the rays proceeding from the discharge tube. The picture to be transmitted is divided up into small sections, each of which is projected in turn upon a selenium cell. At the receiver end a sensitive plate is made to move past an aperture, transmitting the X-rays at a rate corresponding to the motion of the original picture at the sending end. The variations in the current produce a variation in the size of a spark-gap, which in turn produces a corresponding variation in the actinic intensity of the vacuum tube. The greater the deflection of the galvanometer, owing to the elimination and consequent lowering of the resistance of the selenium cell, the more does a brass needle approach a fixed needle representing the other electrode. One of the electrodes of the vacuum tube is attached to a fixed needle, while the other electrode is put to earth and the movable needle is connected with one of the poles of the secondary coil of a Tesla apparatus. The second pole of the Tesla coil is connected with a large capacity.—*Electrotechnischer Zeitschrift* (Berlin), May 2.

Measurement and Calculation.

All sciences at first are qualitative. They pass in their growth from the fact-gathering stage of unrelated qualities to the orderly stage of related qualities, and thence upward to the stage of quantitative correlation under theory. Such, at any rate, has been the course of all sciences hitherto developed, and it seems safe to predict that such will be the course of those that may arise in the future. The recognition of this fact is of prime importance. It helps us to understand the great relative diversity and perfection among the sciences. It affords a basis for rational optimism with respect to the continued progress of science, and it ought to make the specialists of the older sciences less contemptuous than they sometimes are in their attitude toward the newer ones. Measurements and calculations are of all grades and definiteness, ranging from the smallest probabilities of the determination of chances up to the rigorous certainties of mathematical deduction. It is a remarkable fact, illustrating the essential unity which pervades the apparent diversity of nature, that all of the numerous quantities with which physical science has to deal may be expressed in terms of a certain very limited number of arbitrarily chosen numbers or units. The units most commonly used, and those which seem best suited to the requirements of science, are units of mass, length and time. It is by no means certain that these units will best suit the requirements of science in the future. On the contrary, it seems rather probable that advancing knowledge will find some other system of units preferable, if it does not find several different, though interconvertible, systems essential. We have, in fact, already attained such diverse systems in the units of electromagnetic science.—*Science* (New York), June 20.

The Electrical Equipment of the National Physical Laboratory.

The equipment of the laboratory, with regard to the generating and distributing plant and supply, is obtained from a sixty-kilowatt dynamo driven by a Parsons steam turbine, and in addition to this machine there is a smaller dynamo with a Crosley gas engine and motor-generator which can be used as a booster or alone. Ample storage capacity is afforded by three batteries of chloride cells, each battery giving at least 105 volts. One of them is reserved exclusively for electric heating in the thermometric department. Three rooms are devoted purely to electrical work. The smallest room is provided with a thermostat by which the gas heating is regulated in order to preserve a constant temperature. In this room are the British Association standards of resistance, and a Carey-Foster bridge for comparing resistance to a high degree of accuracy. In addition to the historic B. A. coils, which have done such good work, there are a number of manganin standards. Low-resistance standards capable of carrying large currents are also being constructed. The largest electrical room is to contain primary standards, a large concrete slab being reserved for Lorenz apparatus for the absolute measurement of resistance. A part of the room is occupied by a potentiometer. There is also a convenient form of Thompson low-resistance bridge, by which commercial tests of copper conductivity and the like are rapidly carried out. A high-resistance potentiometer is also available for voltage comparisons. In the other main electrical laboratory are being set up a number of secondary standards. A Kelvin current balance, reading to 100 amperes, is already in position, and near it is a specially designed Kelvin reflecting electrostatic voltmeter. This instrument reads directly to 160 volts, and is adapted to the measurement of direct or alternating voltages up to from 1,000 to 2,000 volts, and a potential dividing box of 100,000 ohms has been constructed. The ten coils in it are each wound in 100 separate sections on a wooden frame, well shellaced and baked, and each section is non-inductive. The rest of the room is mainly devoted to capacity and inductance work, the latter including the magnetic testing of iron. Apparatus for the testing of magnetic flux is being installed in very complete form, and the makers and users of glow lamps will be pleased to hear that the director hopes before long to have facilities for testing these for candle-power, efficiency and life. A thermometric department described presents much of interest, and in conclusion it stated that before long there will be set up an apparatus for supplying high voltages for testing insulation resistance, as well as for carrying out many other tests of great importance to the electrical engineer.—*Electrical Review* (London), June 6.

National Telephone Convention.

Sixth Annual Gathering of the Independent Telephone Association of the United States of America, Held in Philadelphia, June 24, 25 and 26.

A CROWD of independent telephone men is always a cheerful gathering, and the men who filled up the rotunda of the Hotel Walton early Monday evening were no exception.

Supply men and manufacturers having exhibits to look after arrived early. From the fact that Philadelphia is beyond the ordinary field of independent telephone activity, which has hitherto been located west of the Alleghanies, many manufacturers anticipating a slim attendance did not make exhibits. The attendance, however, proved to be larger than expected, and it was, underneath a gay exterior, an earnest business gathering, and everything indicates it as a convention that will mark a distinctly progressive movement in the independent telephone field.

TUESDAY'S PROCEEDINGS.

Philadelphia, Tuesday morning, June 24—Tuesday morning found about three hundred delegates and their friends at the ideal convention room of the Walton.

The meeting was called to order at 10.30 o'clock by President James M. Thomas, who called upon Mr. Porter, president of the Keystone Telephone Company, of Philadelphia, who introduced the Hon. Samuel H. Ashbridge, Mayor of Philadelphia. The Mayor's speech was one of hearty welcome to the delegates and friends to the history-making city of Brotherly Love. He expressed his pleasure at seeing that so many of the delegates had brought ladies along and without disparaging any other city in the country called attention to the fact that ladies were safe in any part of the city and would receive courteous treatment and a warm welcome wherever they went. Two years ago he had signed an ordinance granting the Keystone Telephone Company in this city a franchise, an act which had brought malediction upon his head and columns of abuse from certain papers, but for all that he proposed to stand by it, and to-day, as a consequence of that act, we have in Philadelphia a splendid plant, not of unsightly and dangerous overhead wires, but a conduit system giving a service such as people had never enjoyed before and at half the former rates.

People, as a rule, do not believe in monoply and no one company was great enough to be given absolute control of a certain business and not to take advantage of it to the people's disadvantage.

Believing in competition in all things, whether intellectual or material, he had signed that ordinance knowing that sooner or later the people would see that he was right.

The speech of the Mayor was interlarded with a great many witty remarks and was frequently interrupted by enthusiastic applause.

The reply of Mr. S. P. Sheerin, secretary of the convention, was in a happy vein as follows:

Mr. Mayor, on behalf of the Independent Telephone Association of the United States, I thank you for your most cordial welcome to this "City of Brotherly Love."

Our organization, and the interests for which we stand, are represented in every state in the Union. Our people are about up to the average of American citizenship, in morality and intelligence.

We are very much above the average, in our fighting qualities. This, Mr. Mayor, is not because we were naturally better fighters than other people, but because—like the fathers who signed the Declaration of Independence, in this good city, more than a century and a quarter ago—our opportunities for fighting have been excellent.

We are, one and all, anti-monopolists. This is not only a principle with us, but a business and pursuit, as well. We, however, ask nothing that we are not willing to give.

We come nearer to the hearts and homes of the people than any other public utility. The good housewife, who only patronizes a railroad or a steamboat once in a year, wants to talk several times a day. We are facilitators of conversation, aiders in the despatch of business, and great helps to the protection of life and property.

When we were invited to come to Philadelphia, we agreed, as one man, to come. We believe, Mr. Mayor, that every one should come, at least once in a lifetime, to the "cradle of liberty" for inspiration.

We will try to deport ourselves as becometh good citizens, while we stay. Our president, of course, will instruct the delegates that the freedom of the city, which you have so generously offered, does not mean freedom to walk off with the "Liberty Bell," or any other "belle," without the consent of the proper parties.

We know that we shall find many things here to interest us. We feel entirely satisfied that we shall carry away with us many pleasant memories of Philadelphia and her people. Our sincere hope is that we may be able to leave behind us pleasant memories of ourselves.

The next paper on the programme was the address of President James M. Thomas who prefaced his remarks by alluding in a flattering way to the Mayor who had the courage to do his duty and exhibit a far-sighted spirit of enterprise despite adverse criticism. Such men make progress and the benefits he had conferred upon the city would be more appreciated as time went on. He said in part:

Gentlemen of the Convention—In the annual report of the president of the American Telephone and Telegraph Company, under date of December 31, 1901, page 8, we find the following:

"Competition from telephone companies not associated with this company has existed for several years and is likely to continue in some places for some time to come. While it has in some places affected the licensees of this company disadvantageously, by reducing, for a time at least, the number of their subscribers and forcing them to meet competitive rates that are not based upon a proper recognition of the cost of doing business or an adequate appreciation of the amount that should be set aside from earnings for maintenance, reconstruction and depreciation, the consequences of the competition to the business as a whole have not been of serious moment. The public in each community will determine for itself whether it is for its advantage that there should be two telephone exchanges serving one body of people. It would seem as if but one conclusion on this point was possible."

We believe a little closer examination of the subject would have caused the report to say that these low rates are made in the hope of destroying competition. In almost every instance instead of meeting competition rates they have offered ruinous rates, and so far have failed to destroy competition. So that the public so far has not determined whether there shall be two exchanges, except in some instances where the patronage has been withdrawn from the Bell exchange and the same has been closed. The public desires that competition exist in all lines of business, but we do not believe in ruinous competitive rates. And we do not believe as a general rule Independent rates, as they have been established by the majority of companies, are too low. On the other hand they show good business profit.

Our object in this address shall be to frankly, fairly and broadly present the telephone business as it exists to-day, to insist upon rights, to discover wrongs, and if possible to be of some service to the many interests throughout the country; to point out a way of eliminating dangers to capital, which come through mistaken promotion and ruinous rates. We know that capital is needed to carry on this great enterprise which has been given such great impetus through competition. We desire to assure capital that with proper precautions there is no safer investment. We shall therefore begin with rules governing real estate investments and try to apply them to this business as a guide to safe, permanent investment.

The architect who plans well knows every detail of the structure necessary for permanency and harmony before handing the drawings and specifications to the builder. It is quite necessary that the builder fully comprehend the plans and know every detail of structure as conceived by the architect, and apply to this his own knowledge of how to build well without waste. These two men are essential to the interests of the capitalist who seeks a permanent investment.

But before the architect is selected, it is very essential that the land be purchased at a fair, reasonable price, therefore good judgment must be used in the selection of the agent to make the purchase. Then, too, the capitalist must have money enough to fully complete his new property without subjecting himself to usurious charges. With all

these essentials properly combined, the new enterprise is a good business venture from every standpoint.

It pays the capitalist because it is a good investment; the agent, architect and builder because it not only pays well for present labor, but because they have proven competent and faithful provides new employment in the future. This view of making good permanent investments in real estate, however, applies only to the older communities. It does not suit in all its details the pioneer, for he in his new country desires only to take care of his present wants until he can determine the kind of structure most valuable as a permanent investment.

The building of telephone properties has not been known to man very many years. It is fast passing out of the pioneer stage, though no telephone property has ever yet been completed. But now, men who are giving close study to this great and important business believe that the time has come when we should look to the essentials, from the investment standpoint.

This business requires more capital than is to-day at the command of the people who are at work in the building up of telephone properties, a stage that is always reached in the building up of great enterprises.

Like all who work in a common business, we should, in view of this fact, give earnest consideration to the best means of relieving the situation. We have in our meeting to-day enough men to invest during the present year more than was invested the first ten years of the use of the telephone. Local telephone investments are at present limited to the influence of the crowd which undertakes the enterprise, retarded by all other influences that are seeking money for investment in other enterprises, plus the influence of the Bell company working through many of the financial institutions of the country.

Surely no one who has studied the subject will deny that the prospect for the use of the telephone in the future is greater than it has been in the past; that the demand for its use exceeds the ability of the companies to supply it.

Of course we can not look into every detail, or consider disputed rights among inventors. We start here simply after looking at an invention which is not surpassed in point of profound discovery and great use since the beginning of the age of man. If we had comprehended its great value at the time of its discovery as we now do, capital would have undertaken to place it in the hands of the people in a way that would have spread its use more rapidly and more economically than was done in its earlier stages of development. But as all men are made of mud and slow of comprehension, we must—as with everything else—take its slow stages of development as disclosing its weak and strong points.

Broad-minded men are at work on the solution of this problem, and everything necessary to give to the people telephone service at a fair price and give adequate reward to capital and labor will soon be solved. The price, through competition, having in most instances been reduced to the minimum, something must be done to preserve the capital already invested and induce new capital to come into the enterprise.

People should never uphold ruinous competition in anything, any more than they should uphold ruinous monopoly. We must always be fair and just to both sides of a controversy. The user of the telephone must not be allowed to enjoy its great privileges at the expense of the man who has invested his money. We only want such competition as will cause the capitalist to be fair, and not a competition that will give advantage to the user.

The telephone should always be considered as one of the most beneficial enterprises, and should, under proper police restrictions, be welcomed to a city, county or state, without burdens which will affect the rights of the user or the capitalist. The United States, in consideration of its general usefulness, should do everything necessary to reduce the obstacles in the way of establishing full, complete service at reasonable prices. It should do more, perhaps, than to remove obstacles, but that we will not consider.

We find, upon a careful study of this proposition, many difficulties. We believe no other business presents quite as many. We find that through the slow stages of development a long period of pioneering that has cost a great deal of money, which practically has had to be replaced by installing more efficient apparatus and construction every few years. So that the capital invested has grown to very large proportions; where much more capital is necessary to be placed in the business in order to take care of the demand for service within the next year or so.

There is no excuse now for poor construction, inferior apparatus, ruinous rates, overcapitalization, incompetent employés or any other thing that would bring danger to the investor. All we now need is to frankly confess our errors in the past, and proceed as business men in all lines proceed, to properly take care of the capital invested in the business, using modern methods and economies in working out the plan. Let us recognize one another's rights and work in harmony to one common end—to place the business upon a firm financial footing.

The Independent Telephone Association has from its birth taken a stand of recognizing every man's rights. And the work of the officers and committees of the association has always been free from preference or prejudice, and has been conducted upon broad and just principles. The banner of this association has never been trailed in the dust.

We feel that on account of the standing that this association has gained as the representative of the Independent telephone companies of the United States, that it must be the advanced thinker and the advanced worker in this field; that its policy should be ever onward to work out difficult telephone propositions on lines that will be both pleasing to capital and to the people. That its object should not be to destroy, but to build up. That it should not be governed by prejudice, but by justice and fair dealing. We hope and believe that this will be its future course.

On Tuesday afternoon all business was suspended for the purpose of participating in a tally-ho ride tendered to the members and their wives by the local committee. About 150 delegates made up the party, which was thoroughly enjoyable in every sense. The route lay through the most interesting and historic parts of Philadelphia, and the magnificent seven-mile drive through Fairmount and Wissahickon parks. After stopping at the Indian Rock Inn for refreshments the return trip over the splendid road through the magnificent scenery of the Wissahickon was made, and it was agreed that this one feature of the entertainment was worth a trip across the United States.

WEDNESDAY'S PROCEEDINGS.

Philadelphia, Pa., June 26—The session Wednesday morning was late in assembling, owing to the desire of the delegates to visit the manufacturers' exhibits in the Keystone Telephone building which was several blocks away, so that it was 11.15 o'clock before Judge Thomas rapped for order.

In opening the meeting the president stated that Professor W. Elwell Goldsborough, consulting electrical engineer of the Louisiana Purchase Exposition, was present with a communication he desired to read. Professor Goldsborough then took the floor and read a communication from the Business Men's League, of St. Louis, inviting the convention to hold their 1904 meeting in St. Louis during the exposition and promising every facility in the way of rates and accommodations to the delegates. Professor Goldsborough then proceeded to give a great deal of interesting information in regard to the electrical features of the exposition, which promises to be one of the greatest ever held. In the amount of money available, he said there was, first, an appropriation of $6,000,000 by the federal government. The state of Missouri had appropriated $1,000,000; the city of St. Louis, $5,000,000; private subscriptions in St. Louis, $5,000,000 more, and when to this is added the appropriations by the various states there would be enough to bring the total amount to a sum between $30,000,000 and $40,000,000.

The electrical building at St. Louis would be one of the most prominent on the ground, over 600 feet square, or the size of four city blocks. At Buffalo there was 5,000 horse-power installed; at St. Louis there has been 25,000 horse-power already contracted for, which has been already estimated as too little, so that the ultimate installation will probably be 40,000 horse-power. This will be made necessary by the immense power required to show every industrial application in working order. Since the Columbian Exposition, at Chicago, great advance in the electrical arts had been made, and if we could not excel the display at Chicago it could be considered a failure.

As to telephone exhibits it was earnestly desired that in all cases the apparatus should be shown connected to exchanges in actual working order to impress all visitors with the immense strides that have been made in independent telephone apparatus. Independent telephony, he said, has a great future before it not yet understood by the older company, which even yet does not understand the attitude of western people, and he thought it was necessary for independents to take an active interest in this exposition, which will ensure great financial returns.

The speech was warmly applauded by the delegates, and the following resolution offered by Hon. Hugh Dougherty, of Bluffton, Ind.:

Resolved, That we cordially and heart-

ily endorse the plans of the exposition and give them our hearty support and cordial cooperation.

In reply to an objection raised by W. A. Foss, of Cleveland, Ohio, that holding a convention at St. Louis at that time would mean a slim attendance at the meetings, as at Buffalo, where the members, instead of attending the meetings, would be out sightseeing; he explained that the resolution did not commit this convention to a promise to hold its annual meeting there—as that would properly come up later—but as an endorsement of the efforts of the exposition authorities to have the telephone art adequately represented. The motion was seconded and carried unanimously.

Owing to the fact that one of the papers intended to be read at the afternoon session had not been received it was moved and seconded that the convention finish its programme at the present session. Carried.

The reading of the first paper was by Mr. Louis A. Goudy, of the Northeastern Telephone Company, Portland, Me.

Mr. Goudy, who is a forceful, keen-witted and original speaker, prefaced his remarks by a toast to his native state of Maine, and got the audience in a thoroughly good humor before reading his paper.

Mr. Goudy's company, the Northeastern Telephone Company, is the only absolutely independent long-distance company in the field. It has liberal state charters from both Maine and New Hampshire, owns trunk lines which connect between sixty and seventy exchanges and toll stations in as many towns and cities, with 260 miles of pole-line construction, terminating at present at Portland. In conjunction with its connection with smaller companies, it has options on lines which will take it into New Hampshire. The company has nearly 1,000 subscribers, actual and immediately prospective, and the demands are so great that it has been impossible to meet them promptly. Capital is the only requisite to enable it to become the strongest opponent of the Bell company in the East. This the company expects to secure very soon now that plans have become perfected for a large expansion of facilities. The Strowger Automatic Exchange System will be used for the larger exchanges in conjunction with manual party-line service for long-distance connections and smaller exchanges. A selective party device, which makes every subscriber's outfit private, has been successfully tested in some of the smaller exchanges.

Mr. Goudy then quoted the following section from the laws of Maine: "But no corporation organized hereunder shall nave authority, without special act of Legislature, to construct its lines along the route used or authorized to be used by any telephone or telegraph company, person or firm, or between points connected or authorized to be connected by the lines of any such company, person or firm, unless it shall first obtain the consent of such company."

Mr. Goudy said that this statute was enacted about the time that the independent movement began, and he denounced it in scathing terms. Connecticut, he said, had been similarly imposed upon, but not to quite such an extent. The law as there enacted provides substantially that no competition shall prevail unless consented to by the judge of certain lower courts. He then criticised very severely the methods which had been used by the Bell company to defeat or prevent competition, and reviewed at some length the history of the New England Telephone and Telegraph Company, accompanying the review with caustic comment.

In Massachusetts, he said, the companies using the Strowger Automatic Secret Service System are making splendid showings considering the short time they have been operating, and he expressed the opinion that the automatic system is far preferable to the central operator system because of its feature of secrecy.

Mr. Judson stated that the independent telephone companies of the Northwest, particularly east of the Rocky Mountains, have made tremendous strides in growth during the past two years. Prior to that time the entire Northwest was the scene of the same peculiar business methods used by irresponsible promoters of independent telephone companies elsewhere.

The second paper, "The Telephone Situation in the Northwest," by C. H. Judson, of the Twin City Telephone Company, Minneapolis, Minn., was read by Mr. Edward E. Webster, general manager of the Twin City company, who prefaced his remarks by a humorous reference to Mr. Goudy's toast, and in reply to a statement of the latter's paper, in regard to legal or rather illegal restrictions, intended to restrain the rights of independent telephone companies to the use of the public highways, he stated that in Minnesota a law had been passed that highways and streets were public property and that their use by telegraph and telephone companies was only subject to such restrictions of the state or local authorities as were necessary to public convenience and safety, and that this law had been upheld by the courts.

It was then announced that Mr. W. N. Spofford, who was down for a paper at the afternoon's session, was not present owing to serious illness in his family, and that though his paper had been mailed it had not arrived and the reading would therefore be postponed until Thursday morning.

The reading of Hon. H. D. Critchfield's paper was also postponed.

In the discussion that followed the reading of papers, Mr. Webster explained that they had no party lines, that they intended to increase the capacity of their multiple switchboards the coming season. Of the Bell exchanges, seventy-four per cent of their subscribers were in party lines, or to put it in another way, with a switchboard capacity of 3,800 lines they had 8,000 subscribers connected.

In answer to questions, Mr. Goudy was again brought to his feet to explain the fair and unfair methods of warfare that he had to meet in his fight for existence, which must have reminded some of the old-timers of the experience of the early nineties in the Middle West.

Then he proceeded to give a detailed account of unjust legislation, betrayal of trust by managers of some independent companies and official venality that made the delegates wonder if there was an honest man left in the state.

In discussing Mr. Goudy's paper, Mr. Sheerin thought that in regard to the proposition of the Bell company to make connections with independent companies he would say that they have had that experience in Indiana to a very limited extent only. Some time ago five or six companies in his state accepted the Bell proposition to connect with them provided they would cut loose from other independent companies (the total number of telephones involved did not exceed 200), but those men were sorry for their action.

The Central Union (Bell) did not take them into the fold and treat them as it treats its own subcompanies. They also find that they can not make connections with their own county seats or with near-by towns because those towns have organized independent companies and everybody patronizes the new companies. They do not realize until too late that they have surrendered their independence and gained nothing in return. They do not realize that what seems a plausible proposition is a war measure only and does not entitle them to the rights and privileges of the other local Bell companies. It would be much better for the owner of an exchange to sell out even at a sacrifice and get his money out of the business.

Mr. Critchfield said this proposition was fought out in Ohio about two or three years ago when independent companies were few and far between; many of them would have liked, and some of them tried, to make traffic arrangements with the Central Union for toll service, but they would not be considered then. Since then, when exchanges have multiplied so that there is scarcely any unoccupied territory, they now submit their new proposition. But our people now having all the toll-line connection they need they have not met with any success.

The meeting then adjourned till ten o'clock Thursday morning.

THURSDAY'S PROCEEDINGS.

Philadelphia, Pa., June 26—The meeting was called to order at 10.30 by Judge Thomas. In opening the meeting, Judge Thomas introduced Mr. Thomas Martindale, chairman of the Trades' League, of Philadelphia. Mr. Martindale has been for many years actively engaged in the movement for lower telephone rates, not only in Philadelphia, but throughout the state of Pennsylvania. His talk was mostly of a reminiscent nature, describing the early struggles and difficulties involved in the telephone movement in this state. Now, after having fought for lower rates for some eleven years, he saw his reward in the splendid plant being installed in Philadelphia. The reading of the papers was then taken up.

The first paper, "Where We Were, and Where We Are," by the Hon. L. J. Hackney, of Indianapolis, Ind., was then read by the Hon. S. P. Sheerin, in the absence of the author. It was announced that another paper on the programme, "The Independent Telephone Situation," by Mr. Z. B. Campbell, would be omitted. In its place the convention listened to a very interesting talk by Mrs. Anna McElroy Brett, of El Paso, Tex., formerly of Grand Rapids and Detroit. Mrs. Brett is the only woman promoter in the telephone field, and she has been remarkably successful in establishing an independent exchange in El Paso, Tex. The company at the present time has about 300 miles of toll lines and 1,550 contracts, and is now building a toll line to Chihuahua, 600 miles south of El Paso. The rates adopted by Mrs. Brett in El Paso are on a sliding scale. Formerly the Bell company had been giving service at $36 and $60 per year. Her scale was $20 and $30 per year, up to 1,000 subscribers, with an additional fifty cents for each 100 subscribers above 1,000. Her $20 rate has been advanced $23.50. Mrs. Brett was loudly applauded, and the convention congratulated her by a rising vote. The business men of El Paso have become very enthusiastic over the independent telephone movement. At the present time the Bell company has only ten instruments left in the town of El Paso. In order to facilitate the building of toll lines, the business men have offered to buy coupons in large amounts. She also said in trying to get her franchise she had never missed a council meeting in four months.

The next paper on the programme was given by Mr. L. W. Stanton, superintendent of the Federal Telephone Company, of Cleveland, on "Improvements in Independent Telephony." The paper dealt with the traffic management of party lines and toll-line business. This was really the only technical paper at the convention, and was well received and ably discussed. In discussing Mr. Stanton's paper, Mr. J. Breen, solicitor for the Keystone Telephone Company, of Philadelphia, said that the company at the present time had written 12,000 contracts for five years. He joined issue with Mr. Stanton with regard to party-line rates.

The next paper on the programme was by Mr. C. E. Wells, of Marion, Kan., and was entitled "The Independent Telephone Situation in the Southwest."

Judge Thomas then took the floor, with the remark that telephone education should be encouraged by the association, and introduced Professor W. E. Goldsborough, of Purdue University, who outlined the university's course in telephone engineering. He said:

"Our attempt to establish a telephone engineering course is no reflection on the engineers at present in the field who are capable to take care of the situation. With a view of making the plan of education thoroughly practicable and valuable to the telephone people, I have sent out a large number of circulars to engineers and manufacturers all over the country, and have received many valuable suggestions. In planning the engineering course, the first necessity is an essential grounding in mathematics. In that respect we have placed the standard of telephone engineering higher than that required by the regular electrical engineering course. The telephone engineer has to deal with more subtle forces and has need of a higher mathematical education than an ordinary electrical engineer with large forms and heavy weight. The complexity of telephone transmission makes a broad mathematical training necessary, and the requirements in that regard are most severe.

"Now, this does not mean that we neglect the practical application of the art, for we try to have in the university every piece of telephone apparatus manufactured either at present or in the past, and also to keep up with every new improvement known to the art. Our students are made familiar with telephone apparatus which they have to handle, but by means of artificial lines and other applications that occur in every-day practice. Among other things, we have a course in telephone equipment. This is necessary from the fact that no two factories at the present time are equipped in the same manner. It is to be hoped that our course will enable our men to go out in the world, not fully equipped as engineers, but with knowledge enough to save them from a long and tiresome apprenticeship."

Mr. Goldsborough's remarks were well received.

The next paper on the programme was on "The Financial Status of the Independent Telephone Movement," by the Hon. H. D. Critchfield, of Cleveland, Ohio. Mr. Critchfield asked for leave to print his paper later in the proceedings of the convention. It was not complete, owing to the fact that he had been away from home on business for the last few weeks.

The Hon. S. P. Sheerin, secretary and treasurer of the convention, then made the announcement that as he had held the position for four years he considered he had honor enough, and positively declined to stand for reelection. He asked that an auditing committee be appointed to audit the books and reports.

The convention then adjourned to meet at 2 P. M. for the election of officers.

At the afternoon session the following officers were elected: President, James M. Thomas, Cleveland, Ohio; first vice-president, Hugh Dougherty, Bluffton, Ind.; second vice-president, C. E. Stinson, Rochester, N. Y.; third vice-president, W. H. Durin, Cedar Rapids, Iowa; secretary and treasurer, J. B. Ware, Detroit, Mich.; first assistant secretary, C. E. Wilson, Philadelphia, Pa.; second assistant secretary, E. L. Barber, Wauseon, Ohio; third assistant secretary, T. B. Lee, Pittsburg, Pa.

Advisory Board—James M. Thomas, Cleveland, Ohio; S. P. Sheerin, Indianapolis, Ind.; H. D. Critchfield, Cleveland, Ohio; E. B. Fisher, Grand Rapids, Mich.; Samuel E. Wayland, Scranton, Pa.; H. C. Young, Columbia, Pa.; E. E. Webster, Minneapolis, Minn.

Executive Committee—Illinois, George Fair, Chrisman; Indiana, George F. Frier, Muncie; Iowa, Dr. H. S. Herr, Ottumwa; Kentucky, J. A. Armstrong, Louisville; Louisiana, L. H. Lancaster, Thibodaux; Michigan, R. F. Johnson, Saginaw; Maine, L. W. Goudy, Portland; New Jersey, John J. Burleigh, Camden; New York, C. L. Ingham, Buffalo; Ohio, Frank L. Beam, Columbus; Pennsylvania, C. W. Kline, Hazleton; Minnesota, E. E. Webster, Minneapolis; Texas, Mrs. Annie McElroy Brett, El Paso; Virginia, N. C. Watts, Staunton; West Virginia, W. K. Cummings, Wellsburg; Wisconsin, Richard Valentine, Janesville; Kansas, C. E. Wells, Marion.

EXHIBITS.

The Keystone Telephone Company placed part of its handsome quarters on Second street, Philadelphia, Pa., at the disposal of the manufacturers for exhibition purposes.

The Lambert Schmidt Company, New York, showed a line of its apparatus. The exhibit was in charge of Messrs. L. Schmidt, B. O. Bogart and W. W. Bostwick, Jr.

The New Haven Novelty Machine Company, New Haven, Ct., exhibited a line of its new slidable sleeves for lead-covered cables. The exhibit was in charge of Mr. H. Grant Thompson.

The Maybury-Holmes Telephone Company, Medford, Mass., had an attractive exhibit of its party-line system. Messrs. F. E. Maybury and W. H. Holland were in charge.

The Russell-Tomlinson Electric Company's (Danbury, Ct.) apparatus was exhibited by Mr. W. E. Russell, president of the company.

The Stromberg-Carlson Company, Chicago, Ill., had for its representatives Messrs. J. J. Nate, C. W. Stiger, A. F. Rosseau, E. L. Brown and S. G. Reese. The company exhibited many styles of its apparatus.

The North Electric Company, Cleveland, Ohio, had one of the handsomest exhibits at the convention. It was on the ground floor of the Keystone Building. The company's representatives were Messrs. C. H. North, J. P. Downs, Dudley Wick, F. S. Sapp and R. Hendrickson. It distributed a good-luck rabbit's foot as a souvenir.

The Nungesser Battery Company, Cleveland, Ohio, was represented by Mr. P. S. Nungesser.

The W. A. Clark Wire Company and the A. & J. M. Anderson Manufacturing Company were represented by H. F. Sawville.

The Williams-Abbot Company, Cleveland, Ohio, were represented by L. Sands and S. Duvall.

James G. Biddle, of Philadelphia, had an attractive exhibit in the Hotel Walton.

The Okonite Company, New York, was represented by George T. Manson.

The American Vitrified Conduit Company, New York, showed some of its conduits. The exhibit was presided over by B. S. Barnard.

The American Hardware Manufacturing Company, Grottoes, Va. J. A. Livers was the representative.

The D. & W. Fuse Company, Providence, R. I., exhibited its telephone protectors. Mr. W. E. Sisson was in charge.

The Kellogg Switchboard and Supply Company, Chicago, Ill., had as its representatives Messrs. Kempster B. Miller, J. C. Belden, A. E. Barker, Arthur B. Kratz. The company had a large exhibit of its apparatus in the Keystone Building.

The Sumter Telephone Company, Sumter, S. C., had an exhibit of its apparatus in the Hotel Walton. Mr. F. C. Manning represented it.

The Swedish-American Telephone Company, Chicago, Ill., had a line of its apparatus in the Hotel Walton. Mr. E. B. Overshiner represented the company.

John A. Roebling's Sons Company, Trenton, N. J., was represented by Mr. G. W. Swan.

The McRoy Clay Works, Chicago, Ill., was represented by E. F. Kirkpatrick, who distributed handsome pocket measures.

The General Electric Company, Schenectady, N. Y., was represented by H. Wesbury and F. W. Wilcox. It distributed miniature incandescent lamps.

The Monarch Fire Appliance Company, New York, was represented by General Barney, who distributed handsome match-safe souvenirs.

The Twin City Telephone Company, Minneapolis, Minn., had for its representative Mr. Edward E. Webster, general manager of the company.

List of those in attendance at the convention:

Hon. James M. Thomas, President, Independent Telephone Association, Cleveland, Ohio.

H. C. Young, First Vice-President, I. T. A., Columbia, Pa.

C. E. Stinson, Second Vice-President, I. T. A., Rochester, N. Y.

W. H. Durin, Third Vice-President, I. T. A., Cedar Rapids, Iowa.

S. P. Sheerin, Secretary and Treasurer, I. T. A., Indianapolis, Ind.

J. B. Ware, First Assistant Secretary, I. T. A., Detroit, Mich.

C. E. Wilson, Second Assistant Secretary, I. T. A., Philadelphia, Pa.

T. B. Lee, Third Assistant Secretary, I. T. A., Pittsburg, Pa.

Hugh Dougherty, Bluffton, Ind.

H. D. Critchfield, Cleveland, Ohio.

E. B. Fisher, Grand Rapids, Mich.

Samuel E. Wayland, Scranton, Pa.

W. B. Seaton, Ashland, Ky.

George W. Beers, Fort Wayne, Ind.

Geo. W. Fair, Chrisman, Ill.

L. A. Frazee, Connersville, Ind.

A. T. Pressen, Iowa City, Iowa.

J. A. Armstrong, Louisville, Ky.

L. H. Lancaster, Thibodeaux, La.

John J. Burleigh, Camden, N. J.

Ed. L. Barber, Wauseon, Ohio.

Vinton A. Seers, Boston, Mass.

C. W. Kline, Hazleton, Pa.

C. H. Judson, Minneapolis, Minn.

Mrs. Annie McElroy Brett, El Paso, Texas.

R. F. Hogsett, Virginia.

W. K. Cummings, Wellsburg, West Va.

I. H. Moulton, La Crosse, Wis.

Wm. W. Olheiser, Manager, Eastern Telephone and Telegraph Co., Camden, N. J.

Hon. Wm. J. Thompson, Gloucester, N. J.

E. A. Armstrong, Camden, N. J.

Hon. Robt. H. Foerderer, President, Keystone Telephone Co., Philadelphia, Pa.

W. H. Clark, Treasurer, Keystone Telephone Co., Philadelphia, Pa.

W. W. Wharton, Assistant Treasurer, Keystone Telephone Co., Philadelphia, Pa.

R. M. Eaton, Assistant General Manager, Keystone Telephone Co., Philadelphia, Pa.

James Breen, Supt. Contract Department, Keystone Telephone Co., Philadelphia, Pa.

John H. Reid, American Electric Telepone Co., Chicago, Ill., Philadelphia Office.

H. P. Clausen, General Supt., American Electric Telephone Co., Chicago, Ill.

Paul W. Bossert, Manager Phila. Office, Kellogg Switchboard and Supply Co., Chicago, Ill.

F. J. Dommerque, Kellogg Switchboard and Supply Co., Chicago, Ill.

A. M. Worstall, Secretary, Inter-State Telephone Co., Trenton, N. J.

F. A. Demorest, General Supt., Inter-State Telephone Co. Trenton, N. J.

John M. Mack, Philadelphia.

Michael Murphy, Philadelphia.

Jacob E. Ridgway, Vice-President, Keystone Telephone Co., Philadelphia.

Jos. C. Perry, Keystone Telephone Co., Philadelphia.

John C. Sager, Chief, Electrical Bureau, Philadelphia.

Edward Burk, Manager, Electrical Bureau, Philadelphia.

Hon. Samuel Ashbridge, Mayor of Philadelphia.

H. W. Webb, General Manager, Maryland Telegraph and Telephone Co., Baltimore, Md.

E. H. Bouton, President, Maryland Telegraph and Telephone Co., Baltimore, Md.

H. C. Roberts & Co., Philadelphia.

John Mustard, Philadelphia.

H. G. Kepler, Walker & Kepler, Philadelphia.

C. E. Trump, Secretary, Novelty Electric Co., Philadelphia, Pa.

O. H. Larwill, Purchasing Agent, Keystone Telephone Co., Philadelphia, Pa.

C. M. Hamilton, F. Bissell Company, Toledo, O.

H. H. Robinson, United States Telephone Company, Cleveland, O.

Chas. T. Walker, Philadelphia, Pa.

W. A. Hopkins, Jr., Erner-Hopkins Co., Columbus, O.

R. M. Hirst, Standard United States Cable Co., Phila., Pa.

Frank L. Perry, Chicago, Ill.

John J. Flanagan, Chicago, Ill.

G. B. Rudy, York Telephone Company, York, Pa.

W. E. Doolittle, Sterling Electric Company, La Fayette, Ind.

E. B. Overshiner, Swedish American Co., Chicago, Ill.

F. B. Patton, Illinois Electric Specialty Company, Chicago, Ill.

A. J. Rousseau, Stromberg-Carlson Company, Chicago, Ill.

R. C. Hull, Electric Storage Battery Company, Philadelphia, Pa.

Frank R. White, New York, N. Y.

O. C. Snider, Secretary, Kansas City Home Telephone Company, Kansas City, Mo.

R. F. Johnson, Sec'y and Gen. Mgr., Valley Telephone Company, Saginaw, Mich.

R. B. McPherson, Livingston Home Telephone Company, Howell, Mich.

G. W. Swan, Jno. A. Roebling's Sons Co., New York, N. Y.

E. L. Reynolds, Electric Storage Battery Company, Philadelphia, Pa.

Jas. G. Biddle, Electrical and Scientific Instruments, Philadelphia, Pa.

Cecil P. Poole, New York, N. Y.

Elmer E. Smith, Chicago, Ill.

Chas. G. Stevens, Chicago, Ill.

Harry W. Johnston, Columbia Tel. Co., Columbia, Pa.

J. G. Ihmsen, Gen. Mgr., American Electric Telephone Company, Chicago, Ill.

E. F. Kirkpatrick, MacRoy Clay Works, Chicago, Ill.

G. H. Gharky, Consulting Engineer, Philadelphia, Pa.

L. G. Le Bourveau, Sumter Telephone Manufacturing Company, Sumter, S. C.

Thomas Martindale, Trades League of Philadelphia, Philadelphia, Pa.

N. B. Kelly, Secretary Trades League of Philadelphia, Philadelphia, Pa.

E. E. Webster, Twin City Telephone Company, Minneapolis, Minn.

E. F. Edmunds, New York, N. Y.

Harry Huskey, Helios-Upton Company, Philadelphia, Pa.

W. H. McDonough, New York, N. Y.

Raymond Hendrickson, The North Electric Company, Cleveland, Ohio.

J. R. Wilson, Crocker-Wheeler Company, Ampere, N. J.

P. J. Hertz, Illinois Electric Specialty Company, Chicago, Ill.

D. F. Lafeau, President York Telephone Company, York, Pa.

Newman H. Holland, Mayberr-Holmes Selective Signaling and Locking System, West Medford, Mass.

Bleecker S. Barnard, American Vitrified Conduit Company, New York, N. Y.

George S. DuPerow, Engineer, Federal Telephone Company, Cleveland, Ohio.

Allen C. Morse, Federal Telephone Company, Cleveland, Ohio.

H. B. McMeal, Chicago, Ill.

W. W. Townsend, North American Telephone & Telegraph Company, Chicago, Ill.

S. C. Kissner, Citizens' Telephone Company, Coshocton, Ohio.

J. M. Knox, Varley Duplex Magnet Company, New York, N. Y.

J. H. Schofield, Dutchess County Telephone Company, New York, N. Y.

J. B. Rhodes, Zanesville Telephone & Telegraph Company, Zanesville, Ohio.

F. W. Wilcox, Edison Lamp Works, Harrison, N. J.

H. Westberry, Edison Lamp Works, Harrison, N. J.

Frank F. Sapp, The North Electric Company, Cleveland, Ohio.

R. E. Russell, Western Pennsylvania Telephone Company, Covington, Pa.

W. H. Butler, Kent Home Telephone Company, Kent, Ohio.

H. B. Gay, Electric Storage Battery Company, Baltimore, Md.

F. E. Mayberry, Mayberry Home Party Line System, West Medford, Mass.

R. S. Pullen, Leon W. Pullen Electric Company, Philadelphia, Pa.

W. S. Sisson, D. & W. Fuse Co., Providence, R. I.

H. G. Braynards, Western Electric Company, Philadelphia, Pa.

Geo. Breed, Drake-Breed Co., Philadelphia, Pa.

A. E. Bainbridge, Philadelphia, Pa.

C. A. Mans, Anthracite Telephone Company, Hazleton, Pa.

Fred. May, People's Telephone Company, Hazleton, Pa.

J. E. Zeluff, Louisville Home Telephone Company, Louisville, Ky.

W. K. Beard, Philadelphia, Pa.

A. Atwater Kent, Atwater Kent Manufacturing Works, Philadelphia, Pa.

Russell Howland, New York, N. Y.

S. A. Duval, Williams-Abbott Electric Company, Cleveland, O.

T. W. Warner, Warner Electric Company, Muncie, Ind.

John H. Shaper, J. Edward Ogden Company, New York, N. Y.

W. Elwell Goldsborough, Universal Exposition Commemorating the Acquisition of the Louisiana Territory, St. Louis, Mo.

S. M. Granger, Zanesville Telephone & Telegraph Company, Zanesville, O.

H. L. Reber, Gen. Mgr., Kinloch Telephone Company, St. Louis, Mo.

Chas. D. Meyers, Helios-Upton Company, Philadelphia, Pa.

Mortimer L. Godkin, New York, N. Y.

P. J. Enbanks, Harrison Construction Company, Cincinnati, Ohio.

Samuel B. Rawson, Rawson Electric Company, Elyria, Ohio.

W. D. Barnard, United Telephone & Telegraph Company, Philadelphia, Pa.

F. M. Potter, Jr., Syracuse Telephone Company, Syracuse, N. Y.

Irving H. Griswold, American Construction & Trading Company, Elyria, Ohio.

H. B. Coho, Electric Storage Battery Company, Philadelphia, Pa.

Bruce Ford, Electric Storage Battery Company, Philadelphia, Pa.

Telephone Apparatus—II.

New and Standard Designs from the Leading Manufacturers of Telephone and Kindred Apparatus.

Wall Instruments and Switchboards.

The accompanying illustrations show some of the new apparatus recently placed on the market by the Vought-Berger Company, of La Crosse, Wis. This company is the manufacturer of the Pendant telephone, which in a short time has become very popular in all parts of the world. The company is making a full line of magneto and common battery telephones, covering all desirable styles. A new self-restoring board, which is said to be of great merit, and also an ingenious and effective common battery or central power switchboard, will shortly be placed on the market. Realizing the marvelous rapidity with which rural lines are springing up throughout the entire country, and the

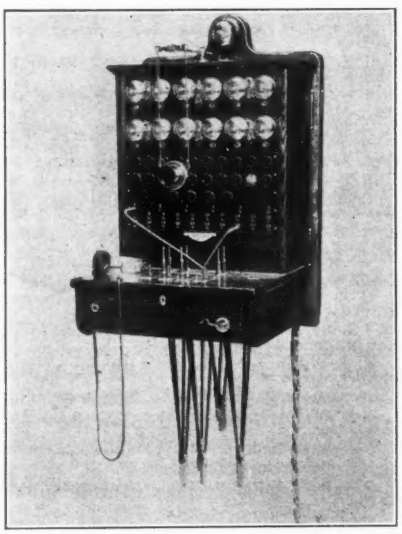


FIG. 1.—FRONT OF COMBINED LOCAL AND RURAL LINE SWITCHBOARD.

value of gathering in these lines and connecting them through a local board, the company has made a special effort to design a reliable equipment to fill the demand for a combined local and rural line switchboard.

Referring to the illustrations, Fig. 1 shows a front view of this board, Fig. 2 giving a good idea of the interior equipment. Fig. 3 illustrates the lightning protector strip. The blocks are tubular, encased in soft iron shells mounted in banks of five. These are removed singly, and the coils can also be removed without disturbing the drop shutter, the jacks being mounted in banks of five to match the shutter. The springs are heavy German silver, the contact being ninety-nine per cent platinum. The plugs are turned from solid brass rods, highly insulated with hard rubber and fitted with red fibre handles. All the insulation is of rubber and mica.

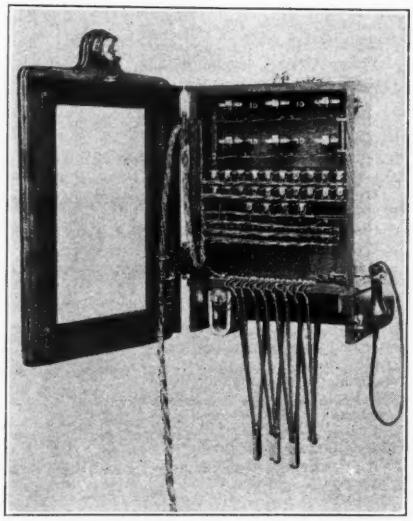


FIG. 2.—INTERIOR EQUIPMENT OF COMBINED LOCAL AND RURAL LINE SWITCHBOARD.

The company makes a special and original device in equipping its bells for indicating line calling, and the same attention is paid to workmanship and equipment as for boards for large exchanges.

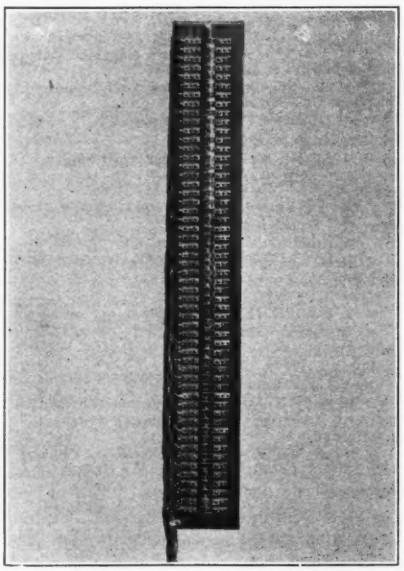


FIG. 3.—LIGHTNING PROTECTOR STRIP.

The board shown in the illustration is equipped with twenty series drops and six high-wound polarized bells. When larger capacity is desired the board is made with a floor cabinet.

A handsome desk set, in which the company claims all points liable to cause trouble have been eliminated, is also rapidly winning favor. All the metal parts are heavily nickel-plated, and the base is of solid brass, engine turned. The switch hook contacts are in the base, and are made dustproof, at the same time being easy of access for inspection. This is shown in Fig. 4. Figs. 5 and 6 show two views of the portable telephone adapted for field linemen's testing and railway use. It is fitted with a four-bar generator, equipped to send out either direct or alternating currents, so that when used for testing, the lineman can call central without disturbing subscribers.

This company is having unusual success with its intercommunicating systems.

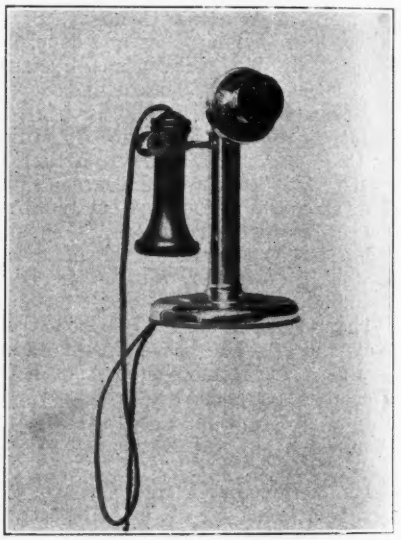


FIG. 4.—NEW DESK SET.

Fig. 7 shows a No. 12 battery call intercommunicating set, which is fitted with the same hand telephone as is used on the Pendant telephone. The switch returns to the home station when the hand telephone is replaced, and in the back view of the instrument the fineness of the wiring is very plainly shown.

Some of the largest mills in the country have been equipped with this company's generator call interior telephone. In this equipment the regular contact dry-battery exchange instruments are used, fitted with a plug box at bottom, and so wired that any station can be called even if the plug has been inadvertently left where last used. With this instrument the transmitter is of the solid back Bell type, with

gold electrodes. No felt washers are used, but the carbon is confined in the chamber

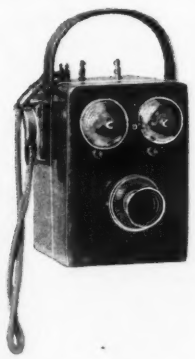


FIG. 5.—PORTABLE LINEMAN'S TESTING SET.

by mica washers held firmly in place by a screw cap. This is a loud, clear talker of

FIG. 6.—PORTABLE LINEMAN'S TESTING SET.

exceedingly good volume. The receiver and generator and ringers the company

FIG. 7.—INTERCOMMUNICATING SET.

has given considerable attention to, and the switch hook is very interesting. This is self-contained, fitted with best German silver springs and platinum contacts. The main spring is laminated, being built up of three light springs, making a positive, slightly rubbing contact on upper points. In order to further protect these instruments from damage by lightning, a heavy carbon arrester is sent out by this company with every telephone.

"Unit" Type Switchboard.

The North Electric Company, of Cleveland, Ohio, in making every effort to follow the development of the independent telephone movement, has given considerable attention to the development of small apparatus which, while not handling service of very great extent, is of a quality

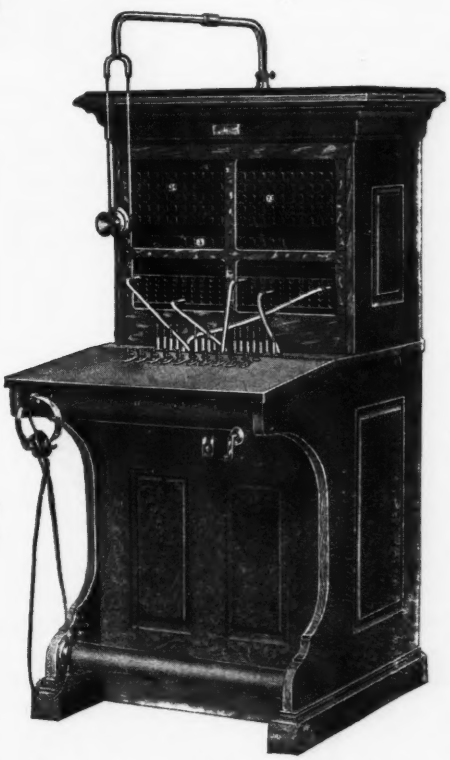


FIG. 1.—MAGNETO CALL BOARD—100 LINES.

equal to that installed in the larger multiple exchanges. This company has brought out and placed upon the market a line of "Unit" type switchboards, two of which are illustrated herewith.

These switchboards are mounted in cabinets which are of uniform design and size, and so constructed originally that several sections may be placed together by the removal of the side mouldings, presenting in connection the appearance of a continuous switchboard. Figs. 1 and 2 show a front and rear view, respectively, of a 100-line magneto call board, Figs. 3 and 4 showing, respectively, a front and rear view of a 200-line lamp signal board with thirty magneto drops. The construction of these cabinets makes it possible to in-

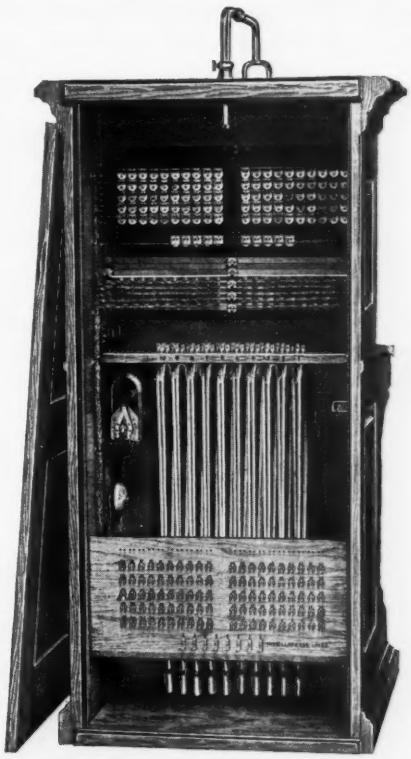


FIG. 2.—REAR VIEW, MAGNETO CALL BOARD.

stall apparatus in small exchanges where, by making additions from time to time as

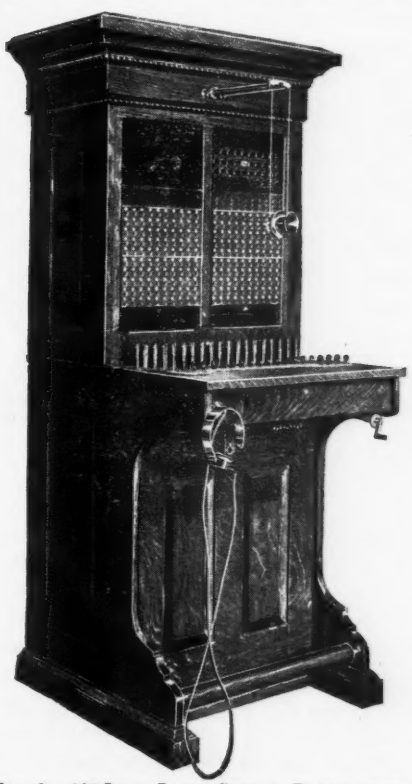


FIG. 3.—200-LINE LAMP SIGNAL BOARD WITH 30 MAGNETO DROPS.

the growth of the exchange necessitates, the expense of installation is met as the

business increases, without the company being obliged to throw out the old equipment. These are made in magneto, call, target-signal and lamp-signal types.

The line drops used in magneto call

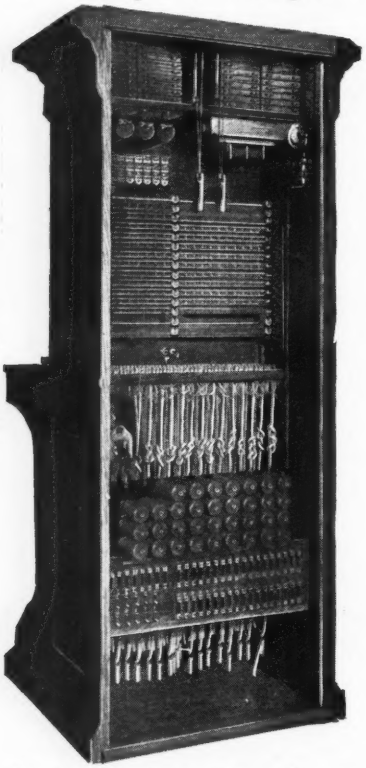


FIG. 4.—REAR VIEW OF LAMP BOARD.

boards are constructed with especial care, the shell being made from solid Norway iron rod, bored out to within three-sixteenths of an inch of the end, thus affording absolute freedom from residual magnetism, as well as maximum impedance and sensitiveness. The armature is suspended from pivoted bearings, and is so arranged that the freedom of action is adjustable. The line contacts in this

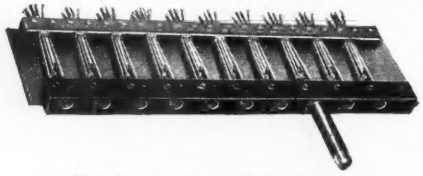


FIG. 5.—STRIP OF LINE JACKS.

type of switchboard consists of German silver springs mounted in rubber strips, each individual jack being separated by mica, the strips being rigidly fastened to a base plate of aluminum. The sleeves of these jacks are made of German silver, reducing the wear to a minimum. Both the target and lamp-signal switchboards are constructed with ample space for the additions of magneto, call and toll-line apparatus.

The lamp jack is somewhat similar in construction to the line jack, the jack springs, as well as the springs containing the opals, being mounted in rubber and rigidly fastened to an aluminum plate. All of the jacks and the signals, whether in magneto, target or lamp boards, are individually movable without disturbing the rest of the equipment. The relays are made so as to be protected by a dustproof case. Fig. 5 shows a strip of the line jacks, Figs. 6 and 7 showing, respectively,

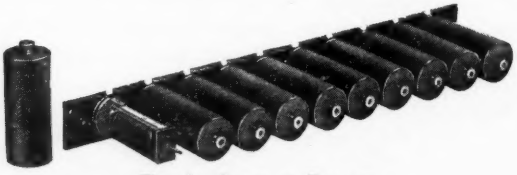


FIG. 6.—STRIP OF RELAYS.

FIG. 7.—RELAY AND DUST-PROOF CASE.

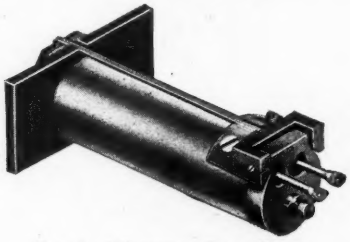


FIG. 8.—MAGNETO CALL DROP.

a strip of relays and the relay and dustproof case. Fig. 8 shows the magneto call drop. Fig. 9 shows a listening and ringing key.

These switchboards are equipped with a terminal rack in the rear, to which all wire is brought, the terminals being marked, or otherwise indicated so as to permit of the least possible chance for mistake in the installation work, as well as to facilitate testing and inspection. These are furnished both with 100 and 200-line equipments for either magneto, call, supervisory or full common battery circuits.

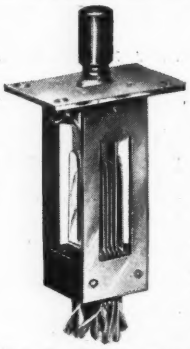


FIG. 9.—LISTENING AND RINGING KEY.

The company furnishes several grades of power-plant apparatus, ranging from primary batteries and a "Warner" generator and small switchboard to a complete double set of storage batteries and fully equipped power switchboard.

Improvements in Common Battery Equipment.

Among the many new improvements which the Eureka Electric Company, Chicago, Ill., has recently placed in the telephone field, the accompanying illustrations show probably some of the latest ideas in this form of apparatus. Fig. 1 is the new platinum concealed contact

FIG. 1.—CONCEALED CONTACT DESK SET.

desk set, which is made of solid brass construction (no spinning), and which the company claims is a type of instrument which has received every consideration to make it of the highest electrical and mechanical perfection. The company is finding an extensive demand for the No. 20 receiver, which is shown in a state of assembly in Fig. 2. This receiver is also made in solid rubber shell, and is one of the simplest receivers, and at the same time hardest to get out of adjustment, which has been placed on the market. Fig. 3 shows the receiver ready to be connected up to the telephone instrument.

This company's common battery type, solid back transmitter is constructed to operate successfully on either twenty-

FIG. 2.—DISASSEMBLED RECEIVER.

four or forty-volt circuits. Its internal resistance is seventy ohms, and it is capable of carrying a heavy battery charge

FIG. 3.—RECEIVER.

without heating or creating any battery action whatever. It embodies new features, and it is impossible for it to get out of adjustment after once installed.

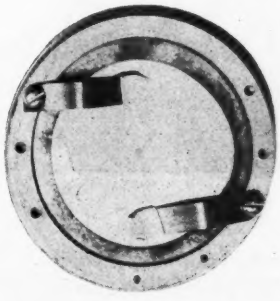


FIG. 4.—SOLDERED CONNECTION OF SOLID BACK TRANSMITTER.

The carbon chamber is constructed in the bridge piece, and the carbon electrodes are soldered, giving them positive action.

These transmitters have met with pronounced success in every independent plant in which they have been installed. This company's flashlight magneto clear-out is claimed to be a decided improvement, and is in successful operation in a great number of plants.

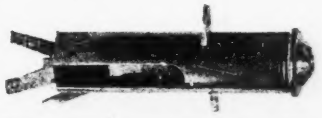
New and Novel Telephone Apparatus.

The Sterling Electric Company, of La Fayette, Ind., has recently introduced in the telephone field some apparatus which is new and novel, and which is radically different from anything heretofore brought out. The company's leader for this year is its common battery lamp signal, double supervisory multiple switchboard of the one-relay type. In addition to this multiple switchboard, specialties which are exclusive are Bell type tubular drop switchboards, flashlight transfer systems, combined cable terminals and protectors, combined main and intermediate iron frame distributing board

COMMON BATTERY DESK SET.

with complete heat coils and carbon protective devices, tubular line fuse, copper test connectors, selective signal, non-interfering party-line telephones.

One of the latest things placed on the market by this company is a common battery multiple system known as the Fowler one-relay system, which is the invention of its electrical engineer. This system reduces the amount of apparatus used to a minimum. The board is made up in sections of one operator's position, constructed of iron frame covered with mahogany or oak, and is accessible at the rear through sliding doors, or at the front through movable panels. Each operator's position is equipped with a telephone set consisting of sixteen pairs of cords and plugs, thirty-two supervisory lamps, giving double supervision, and two operators' cutout plugs and jacks. The lamp jacks, answering jacks and multiple jacks are made up in banks of twenty-five each, the lamp signals being placed immediately over the answering jacks. The complete equipment of one section of the board consists of the keyboard with its complement of plugs, jacks and supervisory lamps, and ringing and listening keys. The face of the section carries 150 lamp signals,

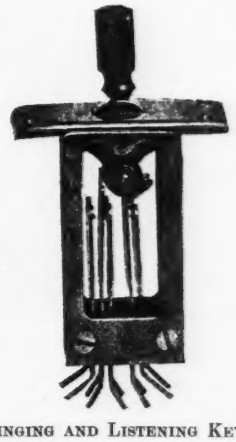


SUPERVISORY LAMP JACK, WITH JEWEL.

answering jacks and its complement of multiple jacks. The rear of the board carries condensers, which are connected in each cord circuit. With the exception of one induction coil and one retardation coil there is, besides the necessary cables, no apparatus in the operator's position. There is but one relay employed, this relay controlling the line signal and both supervisory signals. These relays are located upon a suitable rack, generally in the room with the distributing

OPERATOR'S CUTOUT JACK AND PLUG.

board and power plant. This relay rack with the relays, together with the multiple jacks and answering jacks and the keyboard equipment, constitute all of the apparatus for this common battery switch-



RINGING AND LISTENING KEY.

board. The accompanying illustrations show the common battery desk set and supervisory lamp jack with jewel, an operator's cutout jack and plug, and a standard ringing and listening key.

Artificial Abrasives.

The experiments in producing artificial abrasives that have been in progress during the last fifteen years have met with success, and there are now three artificial abrasives on the market—carborundum, crushed steel and artificial corundum. Carborundum is produced by the Carborundum Company at Niagara Falls, and in 1901 the total production of carborundum was 3,838,175 pounds, valued at from eight to ten cents per pound, as compared with 2,401,000 pounds in 1900. Carborundum is now used to a certain extent as a general abrasive. Crushed steel is used in the stone-cutting trade, particularly by the marble and granite cutters. The production of crushed steel by the Pittsburg Crushed Steel Company in 1901, amounted to 690,000 pounds, being 10,000 pounds less than the production of 1900. A new industry has been started in the manufacture of artificial corundum. The Norton Emery Wheel Company has erected a plant at Niagara Falls for the manufacture of artificial corundum, and already two or three carloads of the material have been manufactured and made into wheels, etc., which are reported as giving good satisfaction.

The Kellogg Three-Tenths-Inch Multiple Jack.

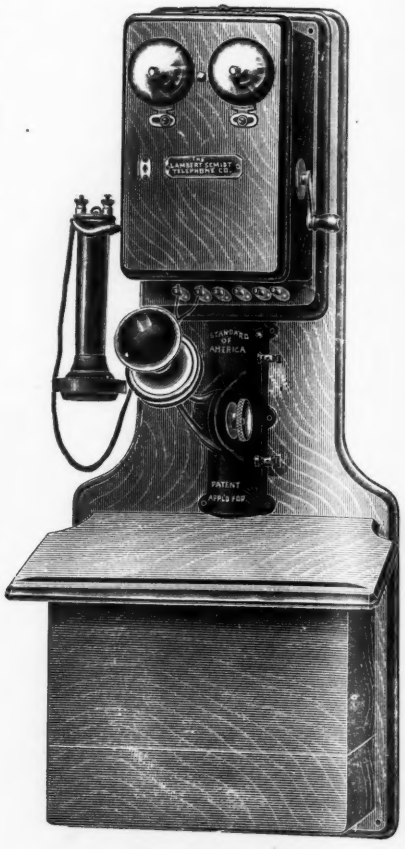
In the accompanying illustration will be noticed the three-tenths-inch multiple jack made by the Kellogg Switchboard and Supply Company, Chicago, Ill. Some very interesting figures in connection with the installation of this jack were given, and a very complete description published in last week's issue of this paper. This jack is known as a two-conductor jack, and is built of the best grade of hard rubber, brass and German silver. One spring in the jack and two contacts in the plug make this capable of being very substantially built, having as high an insulation resistance as most of the jacks on three-eighths-inch centres. This type of jack will be used in the 18,000-line switchboard now building for the Frontier Telephone Company, Buffalo, N. Y., and in the 15,000-line board building for the Home Telephone Company, of Los Angeles, Cal.

BANK OF THREE-TENTHS-INCH MULTIPLE JACKS.

Wall Telephone Sets.

In the accompanying illustrations are shown two of the types of wall telephone sets made by the Lambert Schmidt Telephone Manufacturing Company, with offices at New York city and factory at Weehawken, N. J. This company has recently taken up large exchange work, and is now manufacturing multiple switchboards of any capacity, using either lamp signals or electric self-restoring line-drops. One of the most notable equipments which has been secured is the 500-line capacity multiple switchboard for the Manhattan Railway Company, of New York city. This board is built to stand the most severe service. Many of the instruments will be located fully ten miles from the central, and practically all will be operated continuously. Six operators' positions have been provided. The outfit is of the straight common battery multiple type, and is claimed to be of very excellent construction. This company manufactures a complete line of telephones for every purpose, including exchange equipments and intercommunicating systems for offices and residences.

NEW WALL TELEPHONE SET.



NEW WALL TELEPHONE SET.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Some Interesting Railway Station Equipment.

The Hudson Valley Railway Company is a consolidation of the Stillwater and Mechanicsville, Greenwich and Schuylerville, Glens Falls, Sandy Hill & Fort Edward and Warren County railroads and the Saratoga Traction Company. The company has now in operation over 100 miles of electric road running north from Albany and Troy to Saratoga, Lake George and the Adirondacks. At the present time power for operating the road is derived from several independent power stations located at Stillwater, Saratoga, Middle Falls, Glens Falls and Caldwell. Ultimately, power for operating the entire system will be developed on the Hudson River, near Waterford.

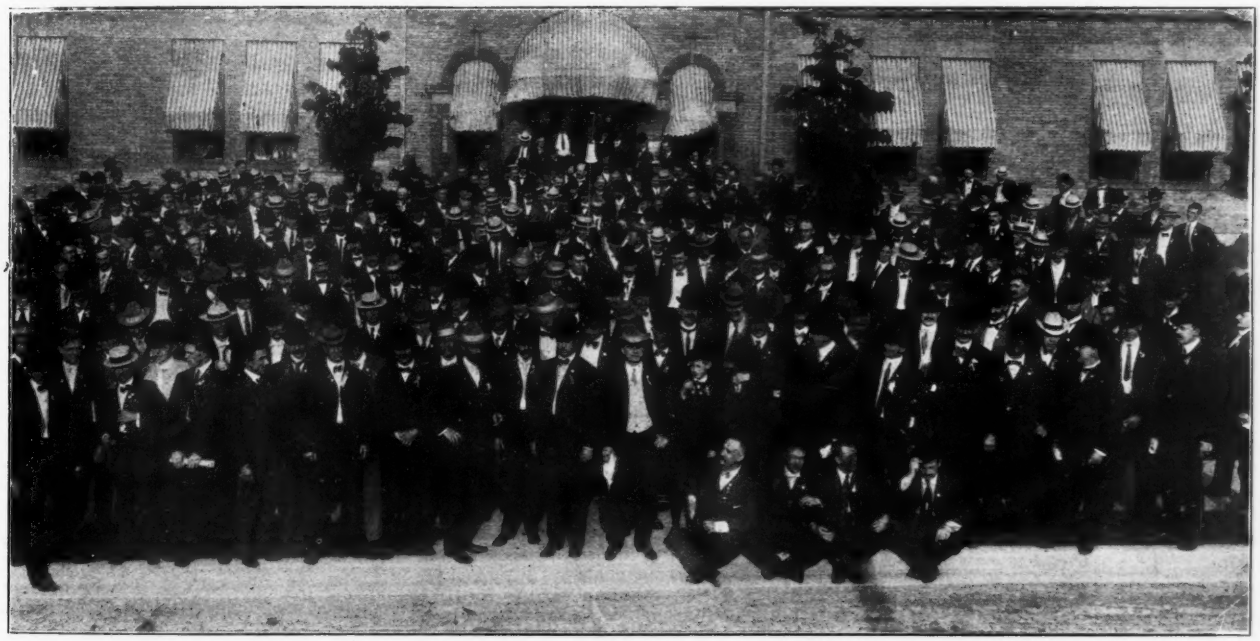
For the operation of the road until the Hudson River power station is completed a somewhat unusual and interesting method will be used. The company has increased the capacity of the direct-current power station at Glens Falls by installing a 250-kilowatt, direct-current engine-type generator and has increased the capacity of the Caldwell station by installing a 270-kilowatt, direct-current belted generator. In the power station at Glens Falls there will be installed a 250-kilowatt rotary converter operating direct current to alternating current with raising transformers. Power will be transmitted by a three-phase, 11,000-volt transmission line to Caldwell where lowering transformers and a second 250-kilowatt rotary converter operating alternating current to direct current will be installed to supplement the power of the Caldwell direct-current generating plant.

At the company's power station in Saratoga there is to be installed a 400-horse-power engine and 250-kilowatt, 2,200-volt belted alternating-current generator with raising transformers. From this power station power will be transmitted by a three-phase, 11,000-volt transmission line to a substation at Round Lake where lowering transformers and a 250-kilowatt rotary converter operating alternating current to direct current are to be installed. This substation will supply power to the recently completed Saratoga division of the system connecting the main line at Mechanicsville with the Saratoga-Balston line at Balston Spa. After the alternating-current generating plant is installed next year on the Hudson River, the generating and substation apparatus now in use and in course of installation will be displaced by eight 300-kilowatt, 600-volt direct-current rotary converters.

All of the electrical apparatus for the temporary installations and also for the permanent equipment of substations is to be built and furnished by the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa.

A Convention Souvenir.

The illustration herewith shows the group of gentlemen who attended the recent convention of the National Electric Light Association, when they visited the works of the Bullock Electric Manufacturing Company at Norwood during the meeting. This party was taken from Cincinnati to Norwood on a special train as the guests of the Bullock company and were entertained by the company during the afternoon. We reproduce the group as it contains the likeness of many representative electricians and those connected with the manufacturing side of the electrical industry. On the extreme right is Mr. F. G. Bolles, manager of the Foreign and Advance Department for the Bullock company, who was in charge for his company.



GROUP OF ATTENDANTS AT NATIONAL ELECTRIC LIGHT ASSOCIATION CONVENTION, HELD IN CINCINNATI, OHIO, MAY 19, 20, 21.

Interesting Wire Experiments for Sound-Carrying Capacity.

During the past week a most artistic little brochure has been issued by the makers of "Phono-Electric" wire, the Bridgeport Brass Company, of Bridgeport, Ct., which contains considerable data of an original nature bearing on experiments conducted under the auspices of the manufacturer of this product, covering the sound-carrying capacity of line wires for telephone and telegraph use. This interesting and highly instructive booklet has been compiled from reports of an investigation by Drs. Louis Bell and Leonard Paget, on the properties of this wire, and is entitled "Several Good Reasons Why 'Phono-Electric' Wire Makes the Best Working Line for Telephony and Telegraphy." A thoroughly scientific and masterly research is accomplished, and the phenomena of electric currents in telephone and telegraph service are comprehensively and graphically described. The proper relations existent between a conductor and its efficiency, with regard to the different ranges of service which it is called upon to carry, are treated in a simple and at the same time deeply technical manner. The phenomena of the reproduction of articulate sounds and the opinions and conclusions of the highest scientific authorities are carefully considered, and many interesting comparisons are drawn illustrating the practicability of this wire for every condition of service.

"Phono-Electric" wire has been produced, after long experience with composite wire, with various bronzes, and with soft and hard-drawn copper, to meet the requirements of lines that must be kept in first-class operating condition twenty-four hours per day, and 365 days in the year. The aim of the manufacturer has been to furnish a material that would combine the strength of iron with the operative qualities of copper, and would produce a line with a large factor of safety, a long line and perfect power of transmitting electrical signals. The claim is made by the manufacturer that "Phono-Electric" wire is twice as strong as soft-drawn copper, one and one-half times as strong as the best hard-drawn copper, and will stand long spans, extremes of temperature and loads of snow and sleet with more than the reliability of steel. The following physical constants may be found in the interesting list appended:

Number B. and S. Gauge.	Diameter in Mils.	Breaking Weight Pounds.	Tensile Strength Pounds per Sq. Inch.	Resistance per 1,000 Feet in International Ohms 75° F.
8	128.5	1,075	82,700	1.555
9	114.4	850	82,460	1.961
10	101.9	685	83,810	2.472
11	90.74	545	84,060	3.109
12	80.81	420	83,700	3.932
13	71.96	340	83,390	4.957
14	64.08	270	83,710	6.251
15	57.07	220	85,210	7.86
16	50.82	180	85,500	9.81

"Phono-Electric" wire has in a unique degree the valuable properties implied by toughness, and under the conditions under which ordinary copper wire would snap, due to kinking or other strains, "Phono-Electric" will bend and yield and save the integrity of the line. Under torsional tests it has demonstrated its ability to stand nearly three times as many complete turns in a given length as hard-drawn copper.

Its elastic limit is said to be forty per cent greater than that of hard-drawn copper, being between seventy and eighty per cent of its tensile strength, hence under a heavy load of snow or sleet it will take no permanent set and sustain no injury from a strain that would bring hard-drawn copper down upon the ground.

The physical and chemical uniformity of the elements entering the composition of this wire is such that it resists corrosion and has no galvanizing which may be affected, as in ordinary material.

In trying to impart added strength to the body of a hard-drawn copper wire, the surface seems to be strained far beyond its elastic limit, so that the strongest part of the wire is not the surface shell, but a shell just within the surface. Outside of this, the fibres of the metal seem to have been over-strained and broken, so that the process of hard-drawing would appear to defeat itself, and leave the product of uncertain quality. Tables compiled from electrochemical examinations of successive concentric shells of wire have shown the unequal distribution of strains in the skin of hard-drawn wire. The resistance of a copper wire is raised from four to ten per cent by the process of hard-drawing, according to the size of the wire and the tensile strength desired. The relation of resistance to the operative properties of telephone and telegraph lines is often seriously misjudged. For clear signaling, the tensile conductivity of the line is of less importance than the proper balancing of inductance and capacity. A long-distance telephone line fails, not because the electrical waves are simply attenuated by the resistance of the circuit, but because they are distorted by improper variations of the other line constants. "Phono-Electric" wire transmits speech with remarkable clearness and sharpness. The claim is also made that this wire is of great value in rapid telegraphy, the signals being delivered with great sharpness, and not being distorted in any way in very long lines.

A Series Long-Burning Arc Lamp.

The Columbia Electric and Manufacturing Company, of New York city, has made improvements which it claims are the outgrowth of long and careful study and experiment upon the problem of arc lamps, consisting essentially in a novel mechanical construction and in additional features which provide a perfect cutout, electrical balance and the control of the gases generated in the vacuum bulb. Great trouble has been experienced in the fact that the excessive accumulation of gas in the vacuum bulb will either force the carbon upward and cause the lamp to cut out or it will generate an excessive heat which deteriorates the bulb.

This difficulty is met by the introduction of an automatic valve which will open when an excess of gas is generated and close when the pressure is lessened, thereby maintaining the same pressure of gas at all times. It is claimed that this lamp will burn 150 hours with one set of carbons. The cutout is exceedingly simple and works entirely by gravity, and is sure of operation under most trying conditions. No dash-pot adjuncts are used, and all connections are so arranged that any part may be removed with an ordinary screw-driver. The lamp will burn on any series arc circuit without change of adjustment.

Another feature of this lamp and one which the manufacturer is confident will make it especially desirable is that it is not necessary to trim the carbons of this lamp daily. This long-burning lamp requires trimming only once in seven days, using one set of carbons. This lamp has been placed in operation by one of the leading railroads, and the company states that the present tests give an assurance of complete success.

The company has just completed the erection of a large works at 316-322 Market street, Newark, N. J., for the manufacture and exhibition of these lamps.

Many years ago Lord Armstrong, the noted English scientist, secured some extremely interesting photographs of the phenomena resulting from discharges of electricity over dust-plates. Entirely in ignorance of what had been done in the same general field, Mr. T. Burton Kinraide, of Boston, has been for years conducting experiments in this field, by which he has carried investigation much further than Lord Armstrong. A paper in *The Century* for July, under the caption "Curious Electrical Forms," will set forth, with illustrations, the character of the so-called positive and negative phases of electric energy, and of a third phase which has never before been revealed. They are the result of several years of experimenting on the part of Mr. Kinraide, and are the record of impressions made by minute electrical discharges upon highly sensitive plates. The text is by Miss Anabel Parker.

CURRENT ELECTRICAL NEWS

COMMERCIAL NEWS

DOMESTIC AND EXPORT

NEW POWER PLANT FOR KANSAS CITY—Within a very short time it is expected that the management of the Metropolitan Street Railway Company will begin work on a new power plant, which is expected to involve an expenditure of $2,000,000. It is announced that the company has completed negotiations for nearly three acres of land, options having been secured upon this for all except two or three streets. As soon as the title is secured, the Metropolitan company will start work. The buildings already upon the ground will be razed and the tract graded. The project contemplates building one of the finest electric plants in the West, from which power will be sent out to run all the car lines in Kansas City.

PACIFIC COAST ELECTRIC RAILWAY—The work of reconstructing the North Pacific Coast Railroad, the narrow-gauge line that runs from Sausalita to Cazadero, is about to be commenced, and the directors are figuring upon plans which have already been decided upon. The money to cover the greater part of the changes contemplated is now at the disposal of the directors of the road. The most prominent of the changes that will be made to the road will be to reconstruct that part of the line between Sausalita and San Rafael and Mill Valley to an electric line. Spurs will be run from the main line into all the gulches in the range of hills which it crosses, where there are many suburban homes. In this way it is proposed to give the best possible transportation facilities to residents along the road. The changes will involve an expenditure of some $750,000.

A NEW TELEPHONE SYNDICATE—It has been announced that a syndicate will be formed to take $1,200,000 of common and preferred stock, the first at $25 per share, and the latter at $100 a share, of the United States Telephone Company. The United States Telephone Company is the long-distance telephone company operated in connection with the Federal Telephone Company. This company is capitalized at $2,000,000. Under the present reorganization plan, it is proposed to retire the floating indebtedness of the company at once. It is said that the control of the company under the new conditions will not be in any one city. Large blocks of stock will be sold in Toledo, Columbus, Akron, Dayton and other cities where the independent telephone companies are financially strong, and the new interests feel very certain of a most successful campaign.

A BIG SUBWAY PLANNED—It is understood that a company headed by ex-Mayor Hempstead Washburn, William A. Alexander and S. S. Gregory, will ask the council of Chicago for permission to build a subway extending to all parts of the city, and honeycombing the entire downtown district. An expenditure of between $40,000,000 and $50,000,000 is projected by the directors, who plan to turn the tunnel over to the city at the end of fifteen years, their compensation during that period to be agreed upon later. The promoters declare that it will require about four years in building, and will mean an expenditure in the city of between $5,000,000 and $8,000,000 per year, and will keep 6,000 or 7,000 men at work during that time. It is announced that everything in the way of capital up to $50,000,000 has been secured and arranged, and thirty days after the ordinance has been passed and accepted work will begin. The project contemplates the use of the subway by traction companies on all sides of the city, its use for all manner of electric wires, including the wires of the Chicago Telephone Company, and possibly, at a later day, of forcing the abandonment of the elevated route in the business district of the city, and the use of the subway by the elevated trains. The ordinance will ask permission to dig from curb to curb and to go to a depth of twenty-four feet.

ARKANSAS VALLEY—According to incorporation papers filed with the Secretary of State at Denver, Col., the Arkansas Valley will have a network of electric railroad lines in the neighborhood of La Junta. The new company is called the Otero Interurban Light, Power and Traction Company, and the incorporators and directors are Charles F. Lacombe, of Denver; William B. Gobin, of Rocky Ford; Horace B. Dye and James W. Beaty, of Manzanola, and Francis M. Wieland, of Fowler, Col. The company is capitalized at $1,000,000. The main purpose of the new company stated in the papers is to construct a system of electric lines in Otero County, and the lines that are to be built are outlined as follows: One line through the county of Otero, east and west through the town of La Junta, and from La Junta south to the southern county line; also lines connecting the cities of Rock Ford, La Junta, Manzanola, Fowler, Ordway and Sugar City. Another line is to extend east from Rocky Ford through what is known as the Holbrook district, and thence back to La Junta. The company proposes to operate these lines by means of electricity, and incidentally to furnish light and power to each of the towns through which the lines will pass. The main offices of the company will be at La Junta. Extensive electric power plants will be erected along the line. It is stated by the promoters that work on the new road will begin as soon as possible, and that it will be hurried to completion. There is plenty of capital behind the enterprise, it is stated.

RAILWAY EXTENSIONS IN MEXICO—The ability of Americans in railroad management is again demonstrated, writes Consul-General Philip C. Hanna, from Monterey, in the improved condition of several lines in Mexico since they have been taken over by American companies. The Monterey & Mexican Gulf Railroad, extending from Monterey to Treviño and from Monterey to Tampico, was built for an American company, but soon passed into the hands of a Belgian corporation, under whose management the line deteriorated. Some time ago the Mexican Central, which is now an American property, purchased the Monterey & Gulf line. It is being put into first-class shape and extended from Monterey to Torreon, where connection will be made with the main line of the Central. It is also understood that the Central will shortly construct a direct line from Tampico to Mexico City, will complete the line which is now building from Tampico to the Pacific coast, and, it is believed, will also build a line from Monterey to some point on the Rio Grande, connecting there with some other system of roads. Several surveys are being made, and there is evidence that this enterprise will shortly extend its lines to many parts of the Republic where there are no roads, thereby developing rich parts of this country which at present have no means of marketing their products. These extensions will not only benefit Mexico, but will strengthen the trade relations with the United States. Besides controlling the lines referred to above, the Mexican Central extends from El Paso, Tex., to the City of Mexico, running beautiful American coaches and Pullman sleeping cars from Mexico City to nearly all the northern cities of the United States.

TELEPHONE AND TELEGRAPH

BUTLER, PA.—The Speechley Telephone Company has been incorporated, and articles have been filed. The company will at once build a twenty-five-mile line through the Speechley oil field.

OMAHA, NEB.—The South Omaha Independent Telephone Company, with a capital stock of $75,000, has been incorporated by the following: W. S. King, A. A. Wright, Thor Jorgeson, Frank Crawford and Thomas H. Healey.

WILMINGTON, N. C.—The board of aldermen at a special meeting passed on its first reading the ordinance granting the privilege to the Southern Bell Telephone and Telegraph Company to put its wires underground in downtown streets.

KANSAS CITY, MO.—The Missouri & Kansas Telephone Company has taken out a permit for the erection of a new branch office exchange. When completed, the structure will be occupied by the old offices. The building is to cost $10,000.

SIOUX CITY, IOWA—Articles of incorporation for the Arlington Telephone Company, of Mowville, have been filed in the office of the county recorder. The company will have a capitalization of $5,000, and will build a telephone system to operate in Iowa.

LARNED, KAN.—The old automatic telephone company has been replaced by a new switchboard system. A new company, headed by Dr. A. A. Sharp, has been organized and has just completed a fine two-story telephone exchange building. Work on the long-distance toll line is being pushed

as fast as possible and when connected up Larned will be able to talk with all towns east to Kansas City.

SYRACUSE, N. Y.—The Central New York Telephone and Telegraph Company is rebuilding all of its toll lines, putting them on a copper metallic basis. The company has lines in nine counties, and 1,200 miles of line will be rebuilt. Twenty thousand new poles are on the line now.

THE FRONTIER TELEPHONE COMPANY, at Buffalo, N. Y., is rapidly constructing its new exchange on Ellicott street, and hopes to be in operation in the comparatively near future. It is said that the company has secured about 1,800 subscribers, and that it purposes to begin operation with at least 3,500.

LORAIN, OHIO—The Black River Telephone Company will increase its capital stock from $50,000 to $100,000, and will spend $70,000 in the reconstruction of its plant. A central energy system will be put in operation, which will have a capacity of nearly 4,000 telephones, besides other improvements, it being planned to erect a new building for the exchanges.

WABASH, IND.—All the stock of the Co-operative Telephone Company at La Fontaine has been subscribed, and the new system is to be put in at once. The company will make a special feature of farmers' service, and over 100 telephones will be installed among the land owners in the vicinity. Connection is furnished by toll lines with all the towns within a radius of fifteen miles.

NUTLEY, N. J.—It has been reported that the New York & New Jersey Telephone Company is about to install a complete system for Nutley, N. J. Poles have been erected, wires strung, and everything is now in shape but the installation and connection of the instruments. It is proposed to connect the new Nutley system with that of Belleville, and have a substation at the latter place. From there, connection will be made with outside points through the Newark central station.

ALBANY, N. Y.—The Commercial Pacific Cable Company has filed a certificate of increase of capital stock from $3,000,000 to $12,000,000. One-third of the cable to be laid between San Francisco and Honolulu is already manufactured. The company is now preparing to proceed with the construction of the remainder of the cable from Honolulu to Manila, a distance of about 6,000 miles, and this increase of capital is in order to provide the cash necessary to complete the cable.

CEDAR RAPIDS, IOWA—The Cedar Rapids & Marion Telephone Company has commenced work on its project of putting in a conduit system in the business part of the city which is to include a fireproof building, 80,000 duct feet of conduit in the business portion of the city, new poles and wires in the residence portion and a new central energy switchboard, with metallic circuit. The whole is to cost in the neighborhood of $125,000. The company is doing the work itself and the engineer in charge is Mr. H. J. Minhinnick, of Chicago.

ELECTRIC LIGHTING

MARIETTA, GA.—The Marietta electric light plant has been sold to the Marietta Electric Company and the new company will improve and enlarge the plant at once.

CONNELLSVILLE, PA.—The holdings of the Connellsville Electric Company have been sold to the West Penn Railway and Light Company. The price paid is said to be in the neighborhood of $150,000. The stock was held exclusively by local people.

HALIFAX, N. S.—A deal has been ratified here by which the Halifax Electric Tram Company has purchased the property and franchise of the People's Heat and Light Company, thus centralizing in one corporation the electric light and gas interests of the city.

BEAVER, UTAH—Beaver is to have an electric lighting system. The city council has granted a franchise to E. A. Hodges, of Beaver, who will commence work at once on a 600-light plant, having leased the water power of the Beaver Woolen Mills Company.

GLEN COVE, L. I.—The Franklin Electric Illuminating Company is to increase its capital stock from $35,000 to $60,000. The plant of this company was recently doubled in capacity, but the continued growth of the summer colonies makes a further enlargement necessary, in order to supply adequate service.

CHARLESTON, W. VA.—The Light, Fuel and Power Company, of West Virginia, with office at Sutton and works at Burnsville, has been incorporated with a capital stock of $2,500,000. The incorporators are: W. E. Haymond, E. B. Carlin, of Sutton; Charles E. Benwell and Reginald C. Bennett, Burnsville, and Henry J. Roberts, New York.

MCKEESPORT, PA.—The finance committee of the council has recommended the expenditure of $60,000 on a city light plant. The contract for furnishing the city with electric light expires next September, and it was proposed to have the city plant ready by that time, but owing to numerous delays this will be impossible. A bond issue will be necessary to build the light plant. City Controller R. A. Hitchens reported to the committee that only $40,000 was immediately available, but that $23,000 would be added to that amount after July 1 from the sinking fund.

BUTTE, MONT.—Another company has been formed to supply Butte with electric light and power. It is composed of George Casey, J. K. Heslet and John F. Cowan. They have located 1,500 horse-power of the water of Race Track creek, about twenty-five miles from Butte, in a direct line. The water will be diverted from the main stream by means of a ditch and will be returned to the stream above any point where the water is now used for irrigation. The fall of the creek is 700 feet in three and one-half miles, which will be the length of the ditch to be constructed. It is expected to put in a general lighting and power plant for use in Butte.

NEW INCORPORATIONS

BUTTONWOOD, PA.—Jackson Telephone Company. $12,000.

POINT PLEASANT, N. J.—The Point Pleasant Traction Company. $200,000.

CADONIA, OHIO—The C. D. Resler Electric Light and Power Company. $5,000.

SHICKSHINNY, PA.—The Lower Luzerne Telephone and Supply Company. $7,500.

SPENCERVILLE, OHIO—The Spencerville Telephone Company. Increased from $20,000 to $40,000.

NIAGARA FALLS, N. Y.—The Niagara Falls Power Company. Increased from $6,500,000 to $9,500,000.

MADISON, WIS.—The Amery Electric Company. $7,500. Incorporators: George F. Griffin, L. Q. Olcott and George Heald.

WRAY, COL.—Wray Telephone Company. $3,000. Incorporators: Howard Klugh, T. B. Groves, L. R. Parker and others.

NEW LISBON, N. J.—Farmers' Telephone Company. $100,000. Incorporators: Henry M. Black, M. W. Hargrove and W. H. Reeves.

LITCHFIELD, ILL.—People's Mutual Telephone Company. $5,000. Incorporators: G. W. Rainey, J. R. Haisley and S. D. Canaday.

MADISON, WIS.—Dane County Rural Telephone Company. $10,000. Incorporators: J. C. Harper, H. C. Winter and H. J. Sutherland.

NEW YORK, N. Y.—The State Electric Company. $1,000. Directors: Sarah A. Miner, Henry L. Stamper and Jacob H. Lubin, New York.

MILWAUKEE, WIS.—Arnold Magnetic Clutch Company. $100,000. Incorporators: Fordyce H. Bottum, Hugh Ryan and H. C. McDermott.

CAMDEN, N. J.—American Electric Improvement Company. $1,000,000 Incorporators: H. Graham Bleakley, Edwin G. C. Bleakley and H. F. Stockwell.

NEW YORK, N. Y.—National Telephone Company. $3,000,000. Incorporators: John H. Lewis, William E. Milne, New York city; James G. Gregg, Morristown, N. J.

FRANKFORT, KY.—The Paducah Street Railway Company. $300,000. Incorporators: A. L. Rich, Charles S. Maltby and Clarence Dallan, all of Louisville, Ky.

PHILLIPSBURG, N. J.—Easton & Washington Traction Company. $100,000. Incorporators: Thomas A. H. Hay, William O. Hay, Easton, Pa.; Robert M. Petty, Washington, N. J.

WAURIEKA, OKLA.—The Farmers and Merchants' Telephone Company. $10,000. Incorporators: J. M. Bellamy, president; G. W. Davis, secretary; A. X. Campbell, treasurer; C. B. Bellamy, vice-president and general manager.

NEW YORK, N. Y.—Consolidated Fire Alarm Company. $2,500,000. Directors: Augustus D. Juilliard, Thomas R. Brown, Manhattan; Bernard M. Ewing, Wyckoff, N. J.; Thomas R. Were, Maplewood, N. J., and Leroy L. Chuin, Montclair, N. J.

ELECTRICAL SECURITIES

As the heated season of summer progresses, there is no doubt in the minds of professional speculators that conditions are looking decidedly bearish. However, unless there should be a material change in the situation, particularly as regards the agricultural outlook, the possibilities of the fall season are distinctly good, with the active probability of a bullish campaign. The coal strike outlook, and the prospect of its extending to the bituminous miners, has of course much to do with the lagging condition of affairs during the past week. The semi-annual payments of July, now about due, have also a discouraging effect, in that it means a tightening in the money market. The money market has held about unchanged during the week, although a hardening tendency is evident in an increased demand for time funds. At the same time, it is impossible to escape the conclusion that rates will go higher before the end of the month.

ELECTRICAL SECURITIES FOR WEEK ENDING JUNE 21.

New York:	Closing.
Brooklyn R. T.	66¾
Con. Gas	220
Gen. Elec	306
Kings Co. Elec	198
Man. El	131
Met. St. Ry	150⅛
N. Y. & N. J. Tel. Co	174
Westinghouse Mfg. Co	210½

Brooklyn Rapid Transit has been reasonably strong during the week. May was a good month, and the officials of the company say that if June does as well, the two will help greatly to make a good annual statement. The report of a week ago showed the gross receipts to be $44,000, an increase of $8,000 over the same week a year ago.

Boston:	Closing.
Am. Telep. & Tel	176½
Edison Elec	275
Mass. Elec. pf	98
New England Tel	147
Western Telephone & Telegraph	102½

Western Telephone and Telegraph common has been selling at 30¼, and the preferred at 102¾. The present advance is believed to be a speculative movement discounting the declaration of a preferred stock dividend in August. The amount of this dividend has not been determined.

Philadelphia:	Closing.
Elec. Co. of America	7¼
Elec. Stor. Bat. c	90
Electric Stor. Bat. pf	90
Philadelphia Elec	5¼
Union Traction	44
United G. I. Co	106

Chicago:	Closing.
Chicago Edison Light	179
Chicago Telep	170
Metropolitan El. pf	90
National Carbon	22¾
National Carbon pf	95
Union Traction	17½
Union Traction pf	52

PERSONAL MENTION

MR. WILLIAM COLE, of the Sterling Electrical Manufacturing Company, Warren, Ohio, spent a few hours in New York during the past week.

MR. HENRY L. SHIPPY, treasurer of John A. Roebling's Sons Company, of New York, is in London this week, combining business with the intention of taking in the coronation of King Edward.

MR. CYRUS O. BAKER, JR., the platinum refiner and importer, returned last week from a month's sojourn in Europe, devoted to business for the house of Baker & Company, of which he is the head.

MR. W. J. PHELPS, of the Phelps Company, Detroit, Mich., the well-known manufacturer of Hylo electric lamps, who was recently in New York city, is attending the convention at Philadelphia this week.

MR. JAMES ROWLAND BIBBINS has resigned as assistant electrical engineer of the Detroit United Railway to accept a position in the Westinghouse Companies' publishing department, of Pittsburg and New York.

MR. JOHN S. SPEER, general manager of the Speer Carbon Company, St. Marys, Pa., spent two days in New York city during the past week. Mr. Speer speaks enthusiastically of the business outlook in that section of the country.

MR. G. F. GREENWOOD, 34 Empedrado street, Havana, Cuba, has been appointed agent for the sale of the chloride accumulator manufactured by the Electric Storage Battery Company, Philadelphia, Pa., in Cuba. All enquiries and business from this section should be forwarded to Mr. Greenwood.

MR. C. T. MALCOLMSON has been appointed superintendent of power of transmission at the World's Fair, St. Louis, 1904, having held a somewhat similar position in the Department of Machinery and Electricity for the United States Commission at Paris, and superintendent of light and power at the Charleston Exposition.

MR. RAY D. LILLIBRIDGE, of New York city, in charge of the literary department of the Stanley Electric Manufacturing Company, assisted in planning and arranging for the visit of the American Institute of Electrical Engineers to Pittsfield on Friday of last week, and much of the smoothness with which every detail was carried out should be credited to his experienced hand. The occasion was a delightful one throughout.

OBITUARY NOTICE

MR. MORRELL MAREAN, the founder of the National Electrical Supply Company, of Washington, D. C., died in his fifty-ninth year on June 22, 1902. Mr. Marean was the vice-president of this company at the time of his death and was well known to the electrical fraternity. Mr. Marean was the manager of the Western Union Telegraph Company at Washington, D. C. He probably had formed, during the past quarter of a century, the acquaintance of more notable men who had held office at the nation's capital than any one residing in that city. His professional duties brought him in contact with the leading men of the nation, from the presidents of the United States down. His death will be very widely mourned throughout the country.

ELECTRIC RAILWAYS

BRISTOL, VA.—The Bristol Belt Line Railway Company has petitioned the council of Bristol, Va., for a franchise for the use of a number of streets on the Virginia side of the city, proposing to extend the Belt line tracks a considerable distance northward.

CHICAGO, ILL.—The Chicago City Railway Company has taken out building permits for the erection of seven buildings, to cover in all seven and one-half acres, at the Vincennes road, to be used as machine shops and other appurtenances, to cost $224,000.

LOGANSPORT, IND.—The Logansport, Rochester & Northern Traction Company, one of the McCulloch lines, has begun laying tracks in the city to the northern limits. According to the company's franchise, it has until July 1 to complete the line, and it intends to have cars running by that time. A temporary power plant will be erected in Logansport.

DAVENPORT, IOWA—At a meeting of the board of directors of the Davenport & Suburban Railway Company, it was decided to increase the capital stock of the company from $500,000 to $1,500,000, in order to meet the demands of the large enterprises they have on, and in the construction and operation of street railways and interurban railways.

KENOSHA, WIS.—The common council has granted a franchise to the Kenosha Electric Railway and Light Company to lay its tracks through the city. The company, which is part of the Chicago, Milwaukee & Kenosha Railway Company, has four-fifths of its tracks already laid, and the balance will probably be completed by July 1. The work of building a road from Kenosha to Waukegan, which will complete the Chicago-Milwaukee route, will also be pushed through, and cars will probably be running between the two cities by September 1.

DULUTH, MINN.—During the summer, the Duluth-Superior Traction Company will spend $300,000 improving its tracks at the head of the lakes, according to President C. G. Goodrich, and the improvements will include both sides of the bay. The old track will be repaired and new rails laid in many places, and when the work is completed the system will have been very much extended. In West Superior the company has already begun the work of putting down the new standard gauge double tracks to South Superior.

NEWARK, OHIO—It has been announced that the Columbus, Buckeye, Lake & Newark Traction Company will purchase the Newark & Granville and the Newark City electric lines. It is understood that the parties associated with this company have a franchise from Granville to the Franklin County line for an electric road through Pataskala, and another franchise in Franklin County. The construction of this road would shorten the run between Columbus and Newark about four miles. This road will tap a profitable part of the coal territory, where at present there is no railway outlet.

INDUSTRIAL ITEMS

THE ELECTRIC CONTROLLER AND SUPPLY COMPANY, Cleveland, Ohio, has removed into its new factory, and is now most spaciously quartered.

CHICAGO FUSE WIRE AND MANUFACTURING COMPANY, 358 Dearborn street, Chicago, has sent to its patrons a unique brass paper-weight.

THE PENNSYLVANIA ELECTRIC COMPANY, Marietta, Pa., is offering the "Crescent" fan motor apparatus. This company has designed a new type of desk fan motor.

STANLEY & PATTERSON, 93 Liberty street, New York, makers of the De Veau telephone apparatus, are offering special inducements to purchasers of sound-proof telephone booths.

THE MAGNET WIRE COMPANY, 141 Broadway, New York city, reports that the sales of its product have very largely increased within the last few months, and it is increasing its facilities to meet this popular demand.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, is distributing a handsomely mounted photograph of the delegates to the convention of the National Electric Light Association, who visited its offices and factories at the time of the meeting.

THE PEERLESS ELECTRIC COMPANY has been organized in Warren, Ohio, with a capitalization of $500,000, for the purpose of manufacturing dynamos and motors, meters and other electrical apparatus. The organizers of this company are well-known electrical men.

E. H. FREEMAN COMPANY, Rochester, N. Y., issues a changeable price list of electrical supplies. This company is the general sales agent for the Crescent Electrical Manufacturing Company, the Genesee Electric Company and the Electric Porcelain Company.

THE AMERICAN INSULATED WIRE AND CABLE COMPANY, 241 to 247 South Jefferson street, Chicago, was awarded a contract amounting to 73,000 pounds of weather-proof copper by the Public Lighting Commission of Detroit, and the order is now being delivered.

THE ELECTRIC GAS LIGHTING COMPANY, of Boston, Mass., and the Stuart-Howland Company, played the second game in the series of contests between the teams made up of employés of these two companies. The game resulted in a victory for the team representing the former company.

THE GORDON BATTERY COMPANY, New York city, manufacturer of the well-known Gordon cell, is making large sales of this battery apparatus. The Gordon cell possesses distinctive features of design and construction which make it peculiarly well adapted for service in its particular field.

THE GOULD STORAGE BATTERY COMPANY, in bulletin No. 1 for May, describes some isolated plants, notably that at Biltmore, the residence of Mr. George W. Vanderbilt in North Carolina. The pamphlet includes half-tone reproductions of interesting points, and also shows the wiring diagram of this fine battery plant.

SMITH & HEMENWAY COMPANY, New York city, announces that it has succeeded to the business of the Yankee Company, manufacturer of the Yankee nail puller. This new succession includes contracts, patents, good will, machinery, tools and plants, and the new company has every facility for properly taking care of all the old and any new patrons who may be interested.

THE FALCON ELECTRIC MANUFACTURING COMPANY, New York, announces that it has established offices at 15 Cortlandt street, and that it will carry in these offices a complete line of its standard switches, panel boards, flush receptacles, etc., etc. The company advises that all further communications should be sent to that address instead of its factory number as previously.

THE MEAD CYCLE COMPANY, Chicago, Ill., announces that its business has gained from year to year until some 50,000 bicycles are sold through mail orders all over the world each year. This company keeps its factory running all winter, storing its wheels, and is ready in the spring and summer to promptly fill its orders. This company makes the claim that it can ship a wheel the same day the order is received, regardless of the business in hand.

THE CONSOLIDATED ENGINE-STOP COMPANY, New York city, is favoring its friends with a handsome souvenir catalogue descriptive of its system of automatic safety devices for use on steam and electric motors. This booklet is well worthy of preservation. It is splendidly printed, the letter press is very comprehensive, and the half-tone work is of a very high order of merit. Numerous applications of this system to different types of apparatus are splendidly set forth.

THE UTICA ELECTRIC LIGHT AND POWER COMPANY, Utica, N. Y., has discontinued its construction and supply department. The former manager of that department, Mr. W. C. Ballda, having taken the active management of the B. & C. Electric Construction Company, a new company organized in March of this year, the officers of which are as follows: E. J. Brown, president; W. C. Ballda, vice-president; B. V. Butts, treasurer, and F. B. Chapman, secretary. The company will execute general construction work and carry a line of electrical supplies.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is adopting an innovation in catalogue distribution which will no doubt be very popular. This company has just issued a new general supply catalogue No. 16, and has in press a general telephone and supply catalogue No. 17, and these are hereafter to be issued annually. The price lists accompanying these catalogues are so arranged that leaves may be inserted in place of those which it is necessary to cancel. Customers will thus be supplied with catalogues brought up to date from time to time, and with prices which are always correct.

LINDSLEY BROTHERS COMPANY announces its removal to Chicago from Menominee, Mich. The necessities of its growing business and the desire to avail itself of the central trading facilities offered by the western metropolis, has induced the Lindsley Brothers Company to remove its offices to 536 Tribune Building, Chicago. While the main distributing yards will, as heretofore, be at Menominee, Mich., all business communications should be addressed to the Chicago office. Attention is also called to the fact that in addition to offices at Menominee, Mich., and Portland, Ore., the firm has now representation also at Spokane, Wash.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., is equipping the Tomboy gold mines of Pandora, Col., throughout for electrical power distribution. The company has recently sold to the Riter-Conley Manufacturing Company, of Pittsburg, Pa., three 200-kilowatt engine-type Westinghouse generators, which are to be direct-connected to Westinghouse gas engines using natural gas. Alternating currents will be used for all work, including cranes; and a number of Westinghouse type F induction motors will be geared directly to straightening rolls. The Steubenville & Wheeling Traction Company has recently purchased two 500-kilowatt Westinghouse railway generators, to be used in the operation of an electric railroad running from Steubenville, Ohio, to Wheeling, W. Va., and also a line from Wellsburg to Wheeling.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has issued, in its Bulletin No. 72, an interesting pamphlet entitled, "Residential Lighting and Power Plants." This sets forth a number of instances where a battery plant is of inestimable value; and the pamphlet is further adorned by numerous fine half-tones. This company recently closed a contract with the Greenfield & Turners Falls Street Railway Company for the installation of a battery of 200 cells, having a capacity of 200 amperes for one hour, with tanks sufficiently large to allow of forty per cent increase. This will be placed in the new car-houses at a distance of ten miles from the power-house, and will be used at this point to regulate the drop in voltage due to the heavy grade which occurs near this station.

THE BAIRD MANUFACTURING COMPANY, Chicago, Ill., has for some time past been engaged in developing a rapid service single-coin machine and also a rapid service meter for telephone lines, which promise to be completely successful. Feeling the need of an expert in switchboard and line conditions the Baird Manufacturing Company has been so fortunate as to secure the services of Mr. David S. Hulfish, who until June 1 was switchboard engineer of the Central Union Telephone Company. Mr. Hulfish assumed the office of secretary and electrical engineer of this company on June 1 and has already designed some great improvements for the new rapid service machines which ensure complete success. The new machine is almost ready for the market and will shortly be placed before Bell telephone licensees.

THE

ELECTRICAL INDUSTRY

Would not be so far advanced to-day were it not for perfect insulation, and

Perfect Insulation

would be impossible but for the use of

MICANITE

which has made possible the use of the large potentials necessary in the operation of the great motors and generators now built.

FOR TEN YEARS MICANITE

has been on the market and has stood the test of time. It is recognized as the STANDARD INSULATION of the world.

MICA INSULATOR CO.,

Patentees, "Originators."

NEW YORK. CHICAGO.
LONDON.

THE GOULD STORAGE BATTERY CO.

MANUFACTURE AND INSTALL

Plants for Regulating Fluctuating Loads of Railway and Power Plants with all Appurtenances

Works: DEPEW, N. Y. Office: 25 WEST 33d ST.

THE ELECTRIC STORAGE BATTERY CO.

PHILADELPHIA.

The "Chloride Accumulator" for Central Stations, Electric Railways, Isolated Lighting and Power Stations, Fire Alarm and Telegraph Service, Train Lighting, Laboratory, etc.

The "Exide Accumulator" for Electric Vehicles

PRICE LISTS AND DESCRIPTIVE BULLETINS FORWARDED UPON REQUEST

— SALES OFFICES —

PHILADELPHIA: 834 Allegheny Ave. & 19th St. NEW YORK: 220 Broadway BOSTON: 60 State Street CHICAGO: Marquette Bldg. BALTIMORE: Equitable Bldg. ST. LOUIS: Wainwright Bldg. SAN FRANCISCO: Nevada Block CLEVELAND: New England Bldg. DETROIT: Michigan Electric Co.

OKONITE
TRADE MARK

WIRE

THAT CAN BE DEPENDED UPON
THAT DOES NOT CHANGE QUALITY
THAT WILL LAST FOR YEARS

For general use where an Insulated Wire is required

D. & W. SAFETY DEVICES

THEY PROTECT LIGHTING, POWER, RAILWAY, TELEPHONE AND FIRE-ALARM CIRCUITS

Send for Bulletins

COLUMBIA LAMPS

HIGHEST EFFICIENCY • UNIFORMITY IN CANDLE POWER • UNIFORMITY IN VOLTAGE • HIGHEST MAINTENANCE OF CANDLE POWER

Try them and be convinced

TYPE K PITTSBURGH TRANSFORMERS

THE TYPE K TRANSFORMER EXHIBITS PERFECT REGULATION UNDER ALL VARIATIONS OF LOAD • WITH ITS MARKED SUPERIORITY IN EFFICIENCY AND DURABILITY WE FEEL SAFE IN CLAIMING THIS TRANSFORMER TO BE WITHOUT EQUAL FOR THREE-WIRE SECONDARY DISTRIBUTION

Bulletins fully describing this System will be sent upon application

We carry a Complete Stock of Electric Light, Power, Telephone and Telegraph Supplies and House Goods

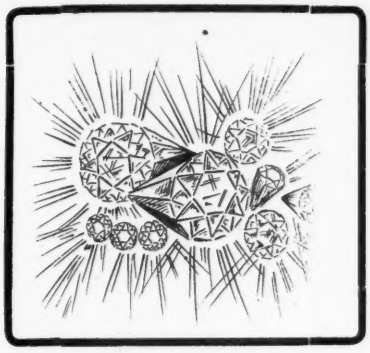
Central Electric Company,

OKONITE IT NEVER DISAPPOINTS

264-266-268-270 FIFTH AVENUE
CHICAGO

OKONITE IT NEVER DISAPPOINTS

DIAMONDS FROM CARBON.



The time is hardly ripe for the actual production of these brilliant gems from carbon, but many owners of lighting plants have felt able to wear them within a year after adopting

COLUMBIA CARBONS.

The saving effected in twelve months has made many a losing plant a profitable investment. We can give you a start in this direction at small expense.

NATIONAL CARBON COMPANY, CLEVELAND, OHIO.

BOOKER CARBON AND BATTERY CO. ST. LOUIS.

"The Phœnix Never Dies"

Anything you want in

Carbon and Battery Specialties

We Make Them and Make Them Right

Quality, Price and Conditions

Booker Carbon Battery Co.

ST. LOUIS, MO. U. S. A.

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REPAIR SHOPS

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FIRST-CLASS EQUIPMENT IN ALL SHOPS

OPEN DAY and NIGHT PROMPT ATTENTION

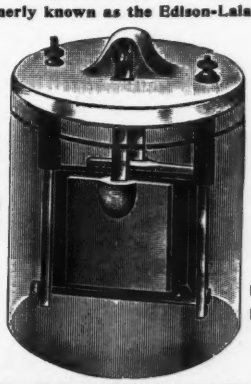
Dynamos, Armatures, Motors, Arc Lamps, Instruments, Machine Shop; Engines, Etc., Carpenter Shops; Cabinets, Etc.

CORRESPONDENCE SOLICITED

EDISON PRIMARY BATTERIES

Formerly known as the Edison-Lalande.

FOR GAS ENGINES, SLOT MACHINES, AUTOMOBILES, RAILROAD SIGNALS, CROSSING BELLS, SMALL MOTORS, ETC. . . .



CONSTANT CURRENT NO LOCAL ACTION, WILL NOT FREEZE. LIQUID TIGHT CELLS FOR PORTABLE WORK

Full Description in Booklet No. 17.

EDISON MANUFACTURING COMPANY.

Factory, Orange, New Jersey, U. S. A. Chicago Office, 144 Wabash Avenue. New York Office, 135 Fifth Avenue. Foreign Department, 15 Cedar Street, New York.

Measuring the new

BABY

Made by

LEA ELECTRIC MFG. CO.

ELWOOD, IND.

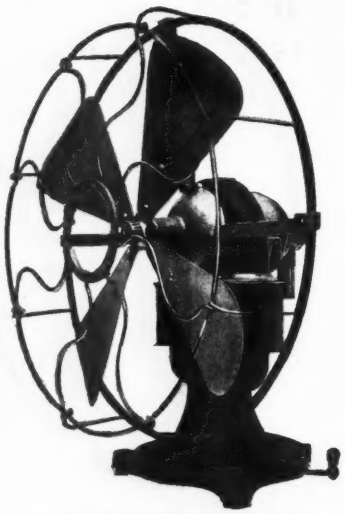
NORTHALL SWINGING COVER ENCLOSED ARC LAMP FOR ANY VOLTAGE.

Send for Catalog

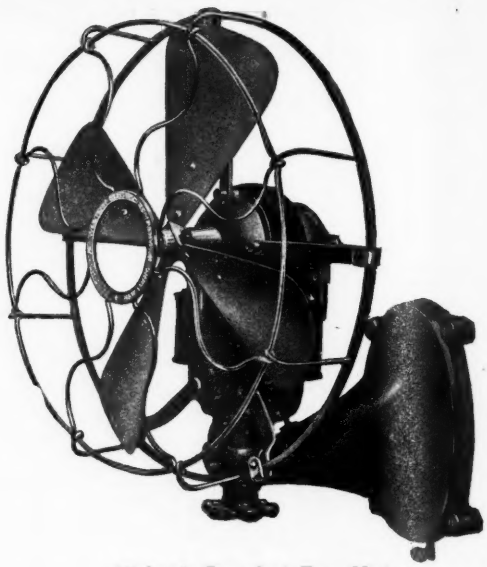
WESTERN

DESIGNED TO OPERATE ON 110, 220, 250 AND 500-VOLT CIRCUITS.

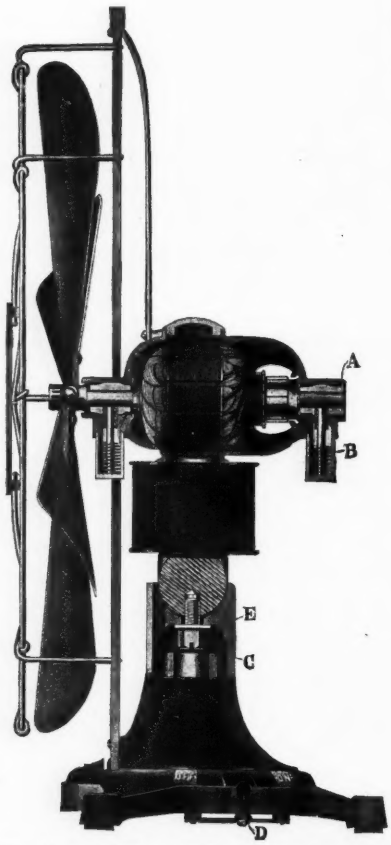
Direct Current.



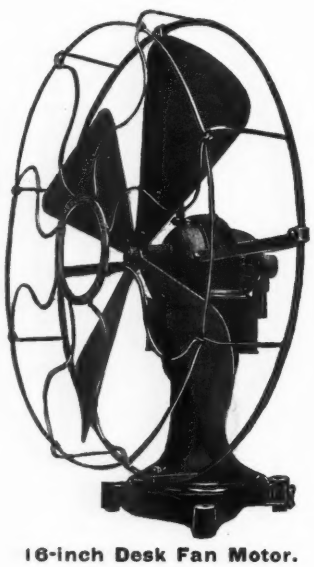
12-inch Desk Fan Motor.



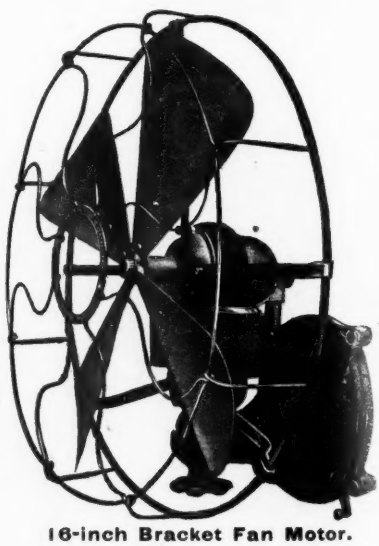
12-inch Bracket Fan Motor.



Sectional View of Desk Fan Motor, showing position of parts.



16-inch Desk Fan Motor.



16-inch Bracket Fan Motor.

OUR CATALOGUE GIVES DETAILED DESCRIPTIONS

WESTERN

Chicago St. Louis Philadelphia New York

AMERICAN ELECTRIC CO.,
St. Paul, Minn.

CALIFORNIA ELECTRICAL WORKS,
San Francisco, Cal.

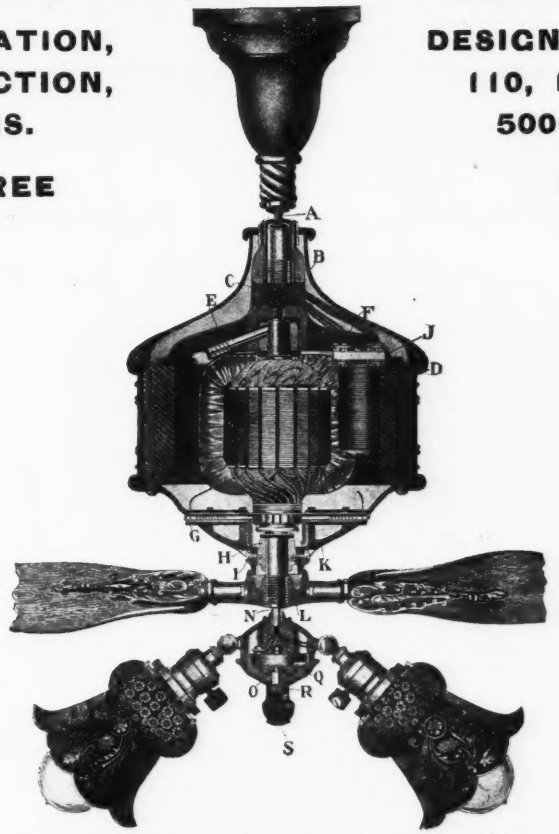
FAN MOTORS

NOISELESS IN OPERATION,
IMPROVED CONSTRUCTION,
ARTISTIC DESIGNS.

OPERATED AT THREE SPEEDS.

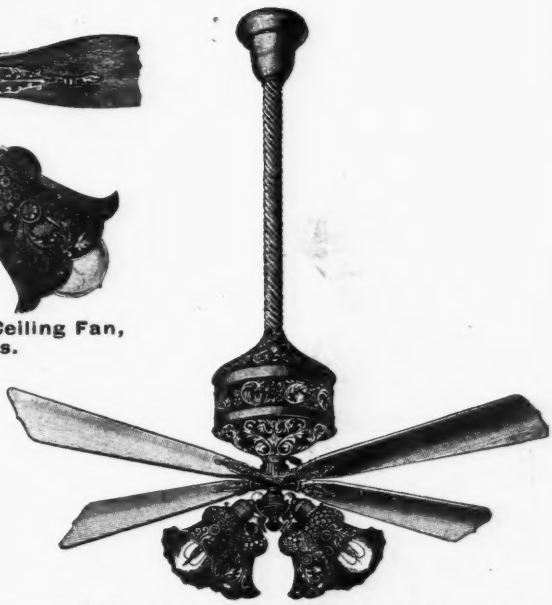
DESIGNED TO OPERATE ON 110, 170, 220, 250 AND 500-VOLT CIRCUITS.

Direct Current.



Sectional View of Direct-Current Ceiling Fan, showing position of parts.

Western Ceiling Fan Motor, with or without Switch.



Standard Ceiling Fan Motor, with Chandelier Attachment, 60-inch Sweep.

SENT ON REQUEST WRITE FOR ONE NOW

ELECTRIC CO.

London Antwerp Berlin Paris

STANDARD ELECTRIC CO.,
Cincinnati, Ohio.

KILBOURNE & CLARK CO.,
Seattle, Wash.

IS YOUR GENERATOR

Running with a zero leakage? When next repaired it can be put in that condition if our insulation is properly applied.

YOUR NEXT NEW GENERATOR

Can show such a condition if your specifications call for it. Motors give service in lieu of unnecessary short-circuits when real insulation supplants acid conveying, oxide hatching varnishes.

Address all inquiries "INSULATION DEPT."

Massachusetts Chemical Co.

200 Summer Street, BOSTON, MASS., U. S. A.

Insulation Plant and Rubber Works, Walpole, Mass.

Authorized Agencies carrying Stock of Genuine Goods:

ST. LOUIS ELECTRICAL SUPPLY CO.
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AMERICAN GENERAL TRADING CO.
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"FLEXDUCT" THE NEW and PERFECT FLEXIBLE CONDUIT for INTERIOR WIRING

Approved by Boards of Fire Underwriters...

"Flexduct" is so superior to everything of its kind now in use that its advantages instantly appeal to all practical men.

Jobbers are eager to handle it because of the rapidly increasing demand.

Leading architects and contractors are pleased to specify and use it in preference to any other conduit of its type, because they are ever anxious to use the most approved materials.

Electricians and owners are desirous of installing it, because it affords the greatest protection to property.

Outer Covering.
Interwoven spiral—the weaving running longitudinally.
Split open—showing perfectly smooth interior, with no raised sections for sharp-pointed wires to catch on.

—From a photograph.

Here are some of the advantages of "Flexduct":

The interior cannot be ripped out, because it is an inseparable part of the conduit—no possibility of ripping out the inside when installing wires too large for the conduit, or when fishing wires through it.

With part of the interior of a conduit gone, and the insulating properties seriously impaired, the installation cannot possibly meet the requirements of first-class work.

When "Flexduct" is used, every foot is absolutely intact and uninjured.

"Flexduct" is positively moisture-proof—made so by closely weaving together a special fibre with a special warp and by treating the conduit with a special compound to fill up the pores.

Send for booklet—also a sample of "Flexduct," and carefully examine its smooth interior; its longitudinal interweaving; test its strength, and satisfy yourself that "Flexduct" is the best flexible conduit that has ever been manufactured for interior wiring.

"Flexduct" costs no more than the old-style conduit.

Order from your jobber.

Osburn Flexible Conduit Co.

General Sales Offices, 21 Park Row, New York City

There Is No Higher-class
India-rubber Insulation
For Wires and Cables than

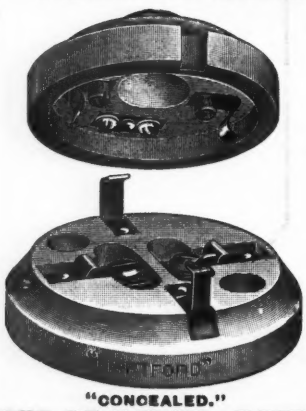
Habirshaw.

Authorized Manufacturers of the
ATTIX FLEXIBLE TUBE Wire.

The India-Rubber and Gutta-Percha Insulating Co.,
Main Office, Glenwood Works,
YONKERS, N. Y.

"BATTERY BRAND"
SAL AMMONIAC.
CHLORIDE OF ZINC.
FUSED AND GRANULAR.
WE SOLICIT YOUR INQUIRIES
The Roessler & Hasslacher Chemical Company,
100 WILLIAM ST. NEW YORK.

"HARTFORD" ROSETTES



FOR CLEAT, CONCEALED AND MOULDING WORK.

Approved by the UNDERWRITERS' NATIONAL ELECTRIC ASSOCIATION.

Cap and bases interchangeable.
Positive lock and sure contact.
Cap can not be loosened or contact lessened by shaking or pulling on the cord.

"CONCEALED."

THE HART MFG. CO., HARTFORD, CONN.....

"The Jewel in the Crown of Southern California."

LOS ANGELES

One of the most beautiful of all the California cities, and the city that showed the greatest percentage of growth in the census of 1900, is the "City of Angels," called Los Angeles.

It is most easily reached from New York and New England and the territory east of Chicago, St. Louis and Cincinnati, by the

NEW YORK CENTRAL LINES

and their connections.

Several excellent hotels, a large number of fine boarding houses and delightful suburbs in every direction make Los Angeles a center for winter tourists.

"Four-Track Series" No. 5, "America's Winter Resorts," sent free on receipt of a two-cent stamp, by George H. Daniels, General Passenger Agent, Grand Central Station, New York.

ELECTRODUCT

TRADE —ELECTRODUCT— MARK

THE ORIGINAL ENAMELED STEEL CONDUIT

Used throughout the world as a raceway for electric wires.

Especially approved by the most eminent authorities for use in fire-proof buildings, warships, merchant vessels, and wherever the best possible protection is required for electrical conductors.

The enameling compound is elastic; it is also acid proof, water proof, rust proof.

"CIRCULAR LOOM"

THE IDEAL FLEXIBLE CONDUIT

FOR INTERIOR WIRING

Approved by All Boards of Fire Underwriters in the United States. Endorsed and Used by Architects, Electrical Engineers and Contractors.

AMERICAN CIRCULAR LOOM COMPANY

CHELSEA, MASSACHUSETTS

NEW YORK — R. B. Corey, 26 Cortlandt Street
CHICAGO — Thos. G. Grier, 128 W. Jackson Boulevard

THE AMERICAN ELECTRICAL WORKS

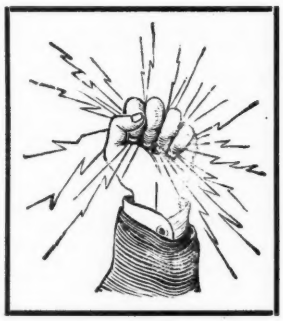
was one of the FIRST factories
in the world to manufacture

Bare and Insulated Wires

for electrical purposes.

To-day its capacity is among the largest in the world, and the Quality of its product is the very highest that is known.

In whatever corner of the world American Electrical Engineering



and enterprise are typified, there will be found this company's products.

The growth of this company is typical of American Electrical industries.

It was coincident with the rise and expansion of American Electrical Engineering.

ELECTRIC LIGHT, RAILWAY, TELEGRAPH and TELEPHONE WIRES

American Electrical Works

PROVIDENCE, R. I., U. S. A.

BRANCHES:

NEW YORK, 26 Cortlandt Street. CHICAGO, 82 Lake Street.

CANADIAN FACTORY, The Eugene F. Phillips Electrical Works, Ltd., Montreal, P. Q.

MAIN OFFICES AND FACTORIES, PHILLIPSDALE, R. I.

If you are engaged in Electrical Work and would avoid sleepless nights and consequent impaired health caused by worry over burn-outs and attendant troubles, follow in the steps of the up-to-date Electrical Men and use the best insulated wires and cables obtainable, which is the world-renowned

OKONITE

cheapest in the end and absolutely reliable. Try OKONITE and MANSON TAPES and CANDEE WEATHER-PROOF WIRE and you will use no other.

Prices and other particulars on application.

The Okonite Company, Limited

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DEEP SEA CABLES

SAFETY

AERIAL CABLES, TELEPHONE and TELEGRAPH CABLES for All Services

AERIAL, UNDERGROUND and INTERIOR WIRES OF THE HIGHEST CLASS Covered with

WHITE REQUA CORE TRADE MARK

"SAFETY"

SEAMLESS INSULATION

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DEEP SEA CABLE NOW BEING MANUFACTURED AT OUR NEW FACTORY ON TIDE-WATER AT BERGEN POINT, N. J.

Safety Insulated Wire and Cable Company

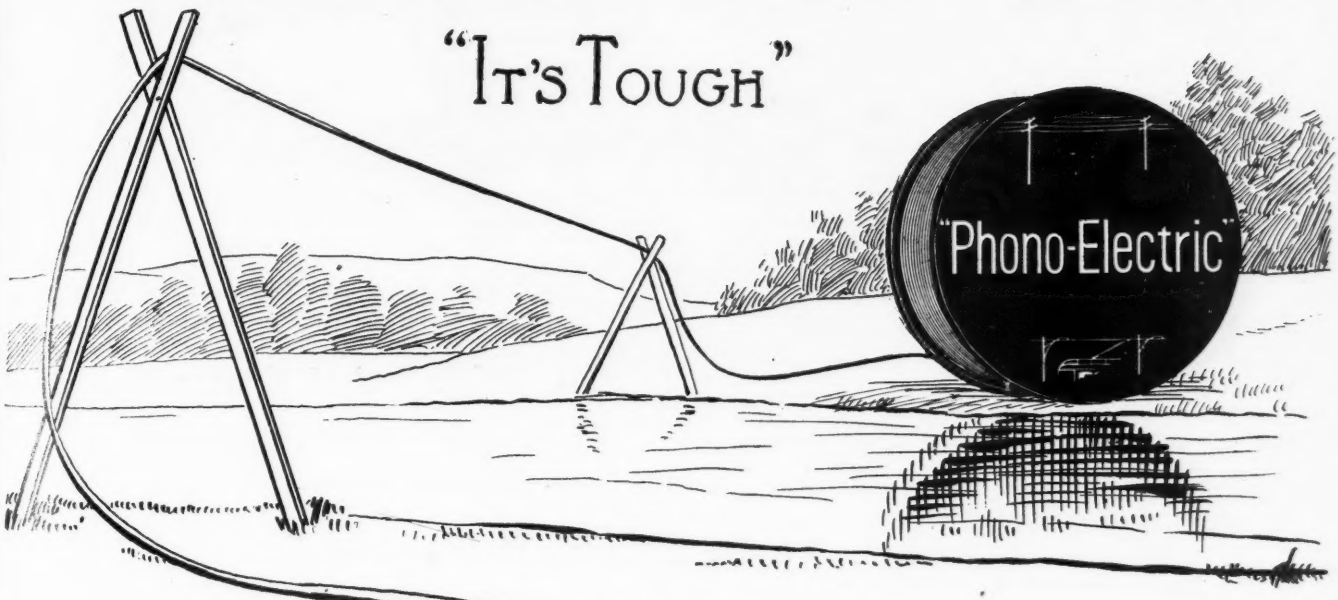
225 to 239 West 28th Street

NEW YORK CITY

LEONARD F. REGUA
General Manager

"PHONO-ELECTRIC" WIRE

"IT'S TOUGH"



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FOR TROLLEY, TELEPHONE AND TELEGRAPH LINES

Bridgeport Brass Co.

19 Murray Street, NEW YORK

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RUBBER COVERED **WIRES AND CABLES**

FOR EVERY SERVICE.

For Underground, Aerial and Submarine use, "SAFETY" wires and cables have the indorsement of some of the largest users in the United States. Write for our booklet containing the experience of users.

The Safety Insulated Wire & Cable Co.

LEONARD F. REQUA, GENERAL MANAGER.
225 TO 239 WEST 28TH STREET, NEW YORK.

NATIONAL ELECTRICAL CODE STANDARD

"O. K." WEATHER-PROOF,
SLOW-BURNING WEATHER-PROOF,
AND SLOW-BURNING WIRE.

PRICES AND SAMPLES ON APPLICATION.

PHILLIPS INSULATED WIRE CO.

OFFICE AND FACTORY: PAWTUCKET, R. I.

The "CLARK" Wire

FOR SWITCHBOARD, RAILWAY AND MOTOR USE.
All sizes of stranded and flexible wire and cables with Clark's insulation.

Inspector Boston Fire Underwriters' Union says:—"A thoroughly reliable and durable wire in every respect."

The Clark wire has been before the public, and in use, for the past 10 years and has met with universal favor. We guarantee our insulation wherever used, Aerial, Underground, or Submarine, and our net prices are as low, if not lower than any other first-class insulated wire. We shall be pleased to mail Catalogues, with terms and discounts for quantities.

Eastern Electric Cable Company,

61-63 HAMPSHIRE STREET, BOSTON, MASS.

Henry A. Clark, Treas. and Gen. Manager. Herbert H. Eustis, Prest. and Electrician.

We have now a complete stock, sizes No. 18 to 0000, inclusive, of the celebrated

"IXL" Triple Braided Weather-Proof Wire.

No better wire made. Price same as other wires. Send us an order.

ST. LOUIS ELECTRICAL SUPPLY COMPANY,

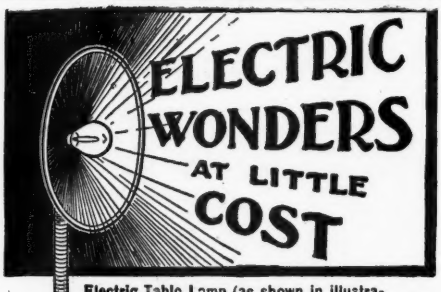
1118 Pine Street, St. Louis, Mo.

HAZARD MANUFACTURING CO., WILKESBARRE PA.

HIGH-GRADE RUBBER-COVERED WEATHERPROOF **WIRES and CABLES.**

Magnet, Office, Annunciator Wire.

NEW YORK OFFICE, 50 DEY STREET. CHICAGO OFFICE, 1201 MARQUETTE BUILDING.



Electric Table Lamp (as shown in illustration) with Battery complete	3.00
Battery Hanging Lamp	10.00
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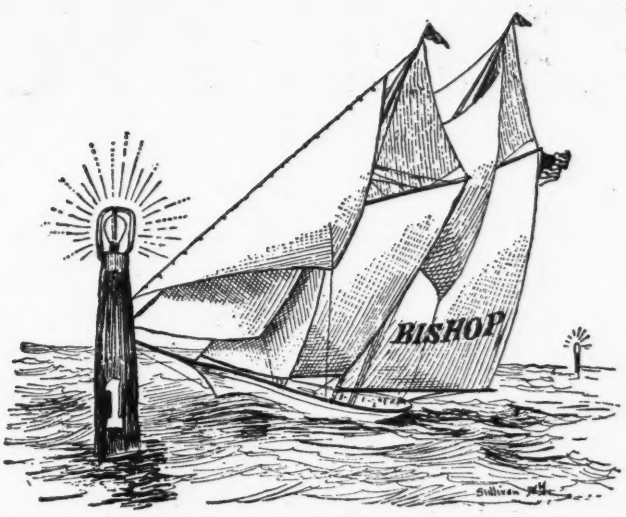

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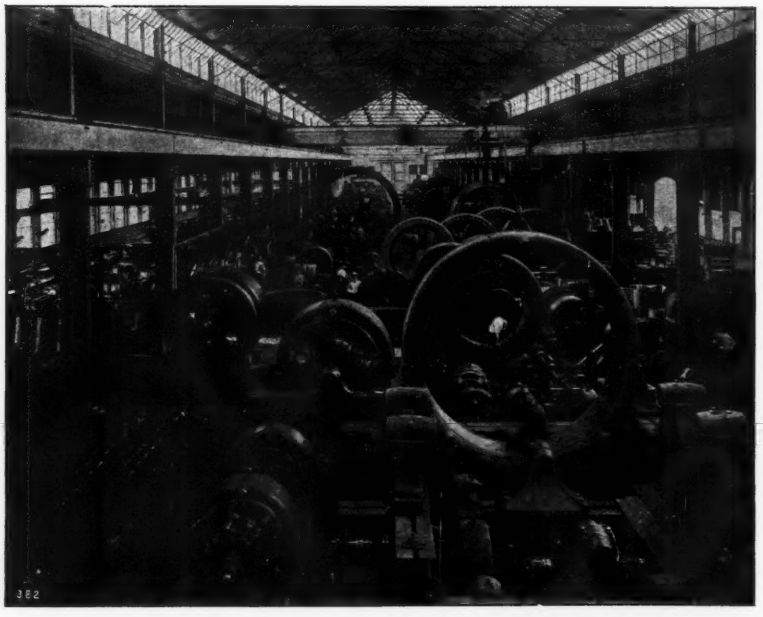

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Our product has stood the test of time and is to-day conceded by engineers of standing and ability to be superior from both electrical and mechanical standpoints

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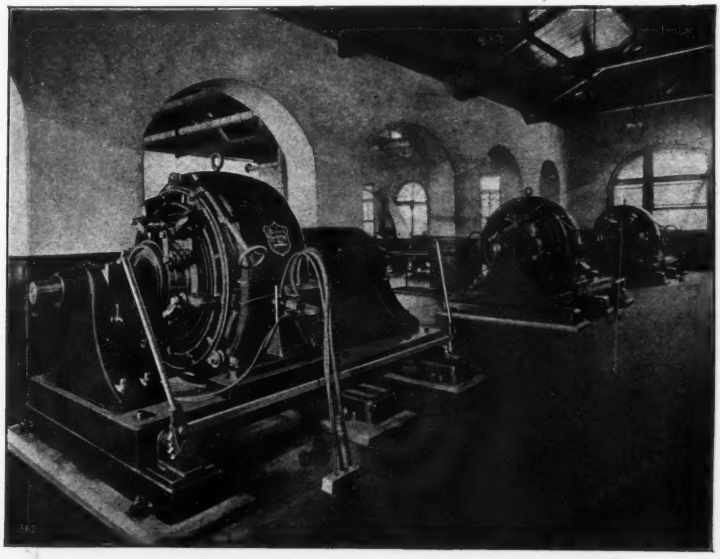
BULLOCK

RAILWAY GENERATORS



Three 200 K.W. Bullock Belt Driven Railway Generators; People's Railway Co., Wilmington, Del. (Two more 350 K.W. Machines now being Installed.)

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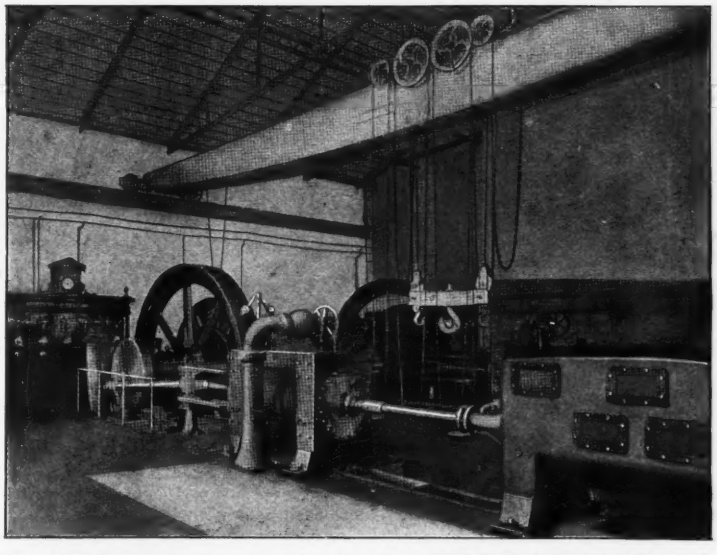

300 K.W. Bullock Engine Type Railway Generator, 90 R. P. M., Installed at Plant of Railway of Fournirles-Ouest, Lyons, France.

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BULLOCK

Details of Construction

RECEIVE THE CARE AND ATTENTION NECESSARY FOR PRODUCING WORK OF THE HIGHEST ORDER

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Typical Winding of Bullock Three-Phase Generator Armature.

GOOD ENGINEERS RECOGNIZE THIS FACT AND SPECIFY *BULLOCK GENERATORS* AND *MOTORS* THE FINISH OF *BULLOCK* MACHINES IS CHARACTERISTIC OF WHAT MAY BE FOUND IN ALL PARTS

Bullock Electric Mfg. Co., Cincinnati, U. S. A.

359

BULLOCK

ARMATURE CONSTRUCTION

If there is any one feature more than another of our machines that deserves special consideration it is the construction of our armatures for our three bearing belt driven and engine type machines. To graphically illustrate the advantages, we show in *Fig. 1* a ring built from segments of sheet metal, the joints of one layer being midway between the joints of the adjacent layers. The several layers are then bolted together, and it is evident that the strength of the rim is equal to the shearing strength of the bolts used, supplemented by the friction of the plates on each other. In *Fig. 2* we show the same construction except that

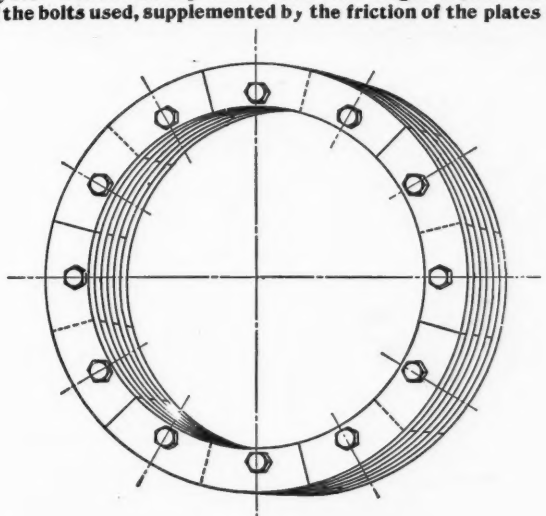


Fig 1.

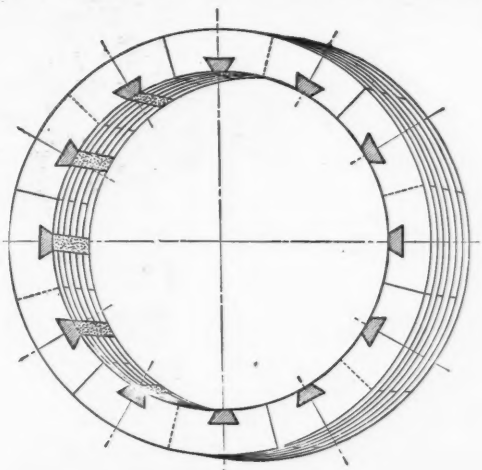


Fig. 2.

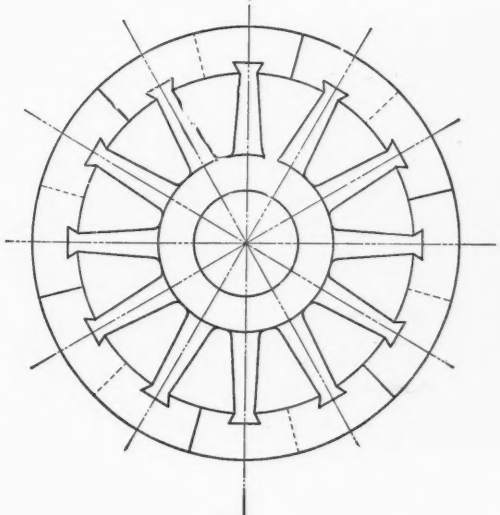
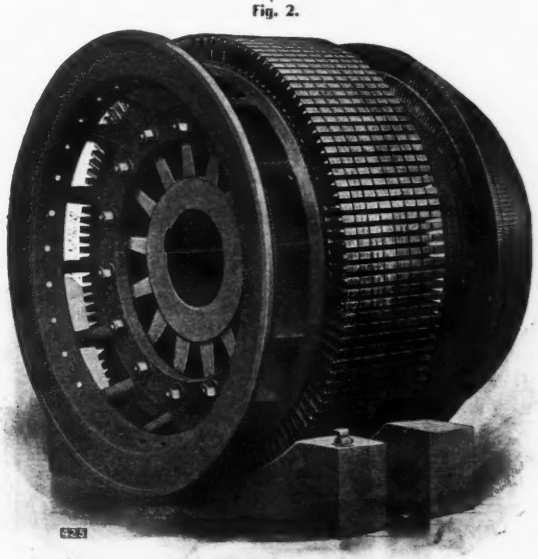


Fig. 3.



Armature Core and Commutator 250 K.W. Bullock Railway Generator.

we have substituted cast-iron pieces dovetailed into the sheet metal, with end plates bolted together to keep the laminæ in place. The strength in this case is dependent upon the shearing strength of cast-iron, plus the friction of the plates.

Now let us connect these dovetail pieces of cast-iron with the arms of a spider as in *Fig. 3*, and we have the construction of armature cores for Bullock Three Bearing Belt Driven and Engine Type Machines. The only work which the spider is called upon to do is to rotate the rim and to keep it central; the rim, owing to its peculiar construction, being able to resist all strains due to centrifugal force without the aid of the hub or arms. This construction also gives the maximum amount of space for ventilating ducts. Competing designs are just the opposite in construction, and depend upon the tensile strength of cast-iron to resist the tremendous bursting strains due to centrifugal force set up when the machine is in operation. The ventilation in such machines is also greatly obstructed.

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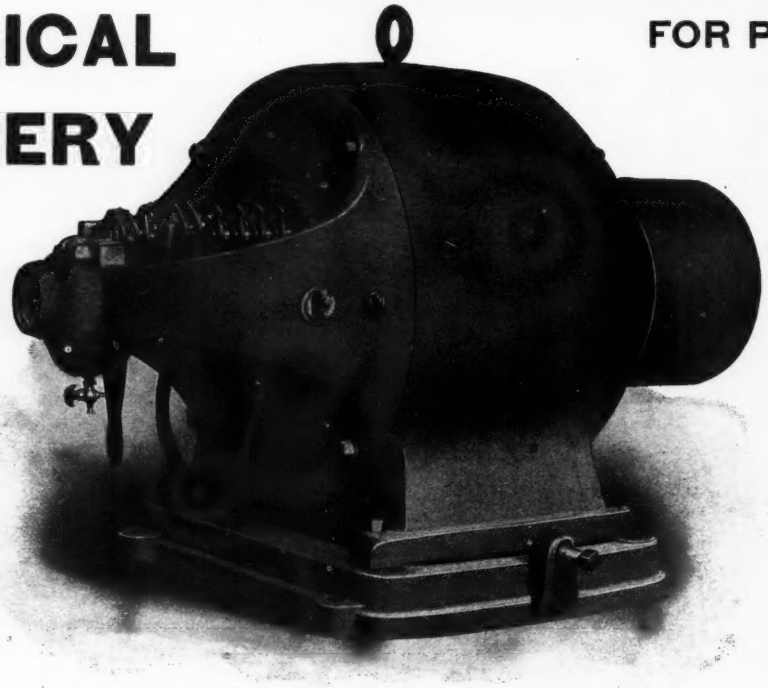
ELECTRICAL MACHINERY

FOR POWER AND LIGHTING

Milwaukee Type.



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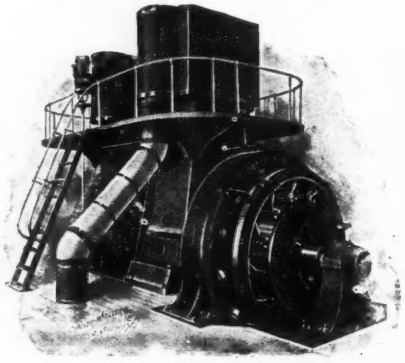

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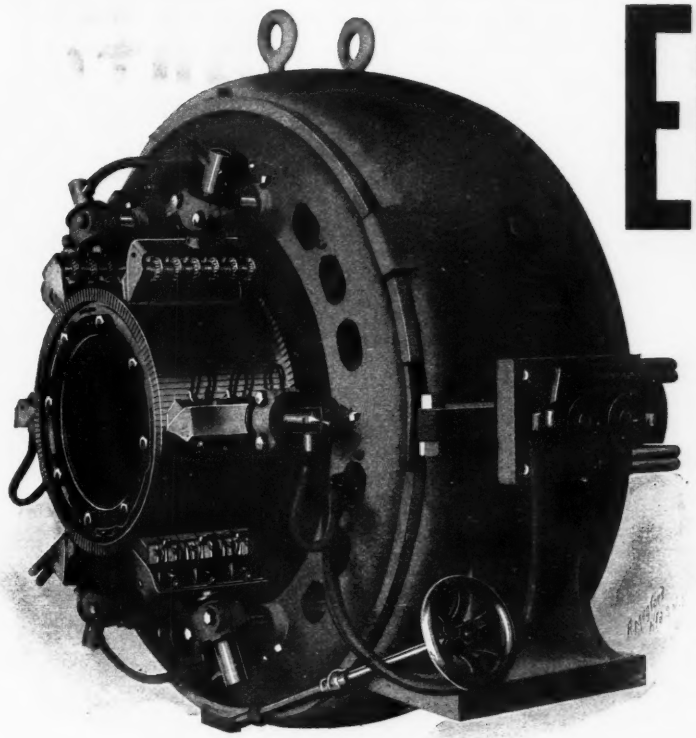

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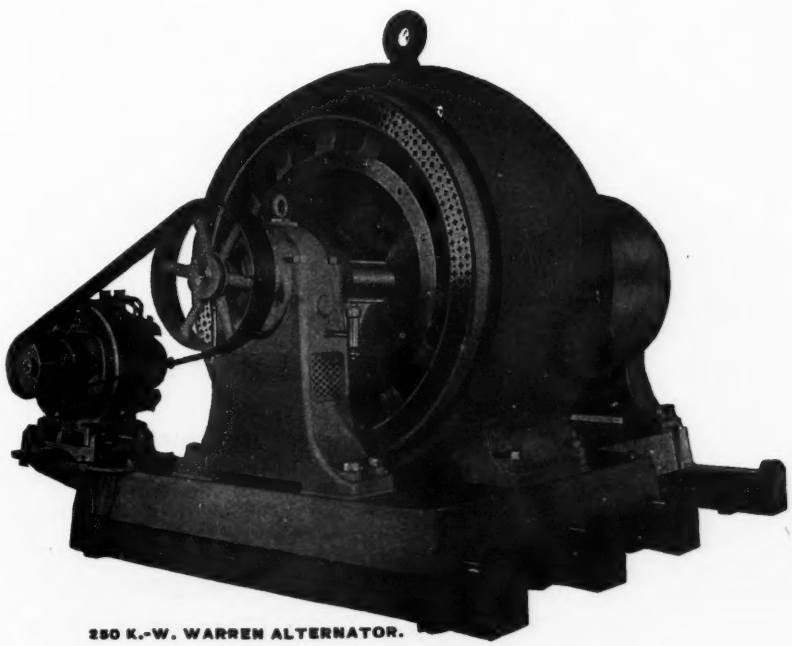

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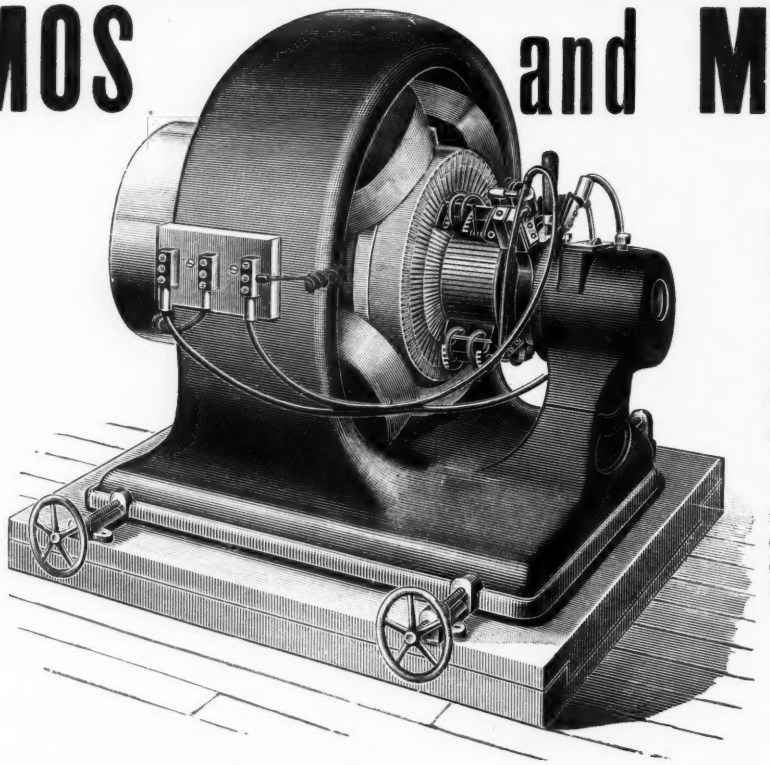

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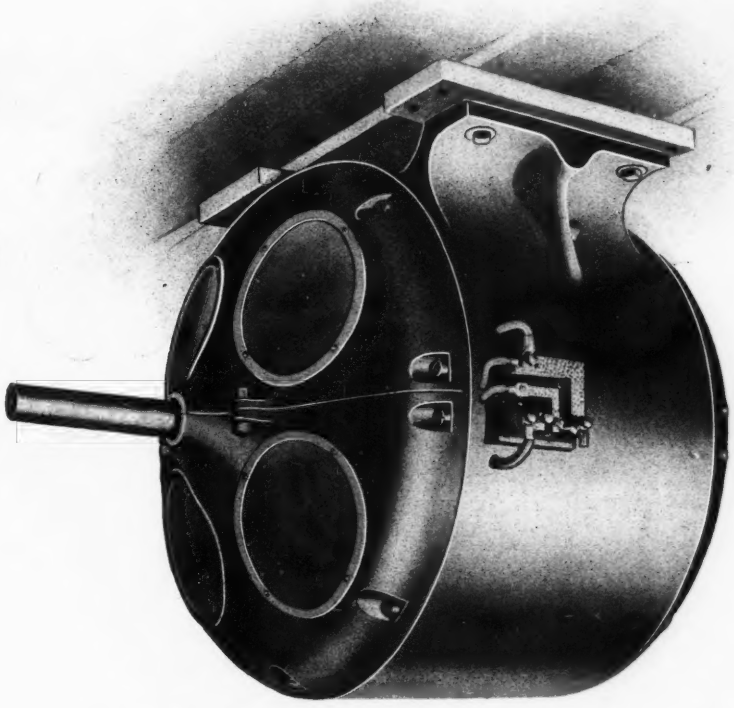

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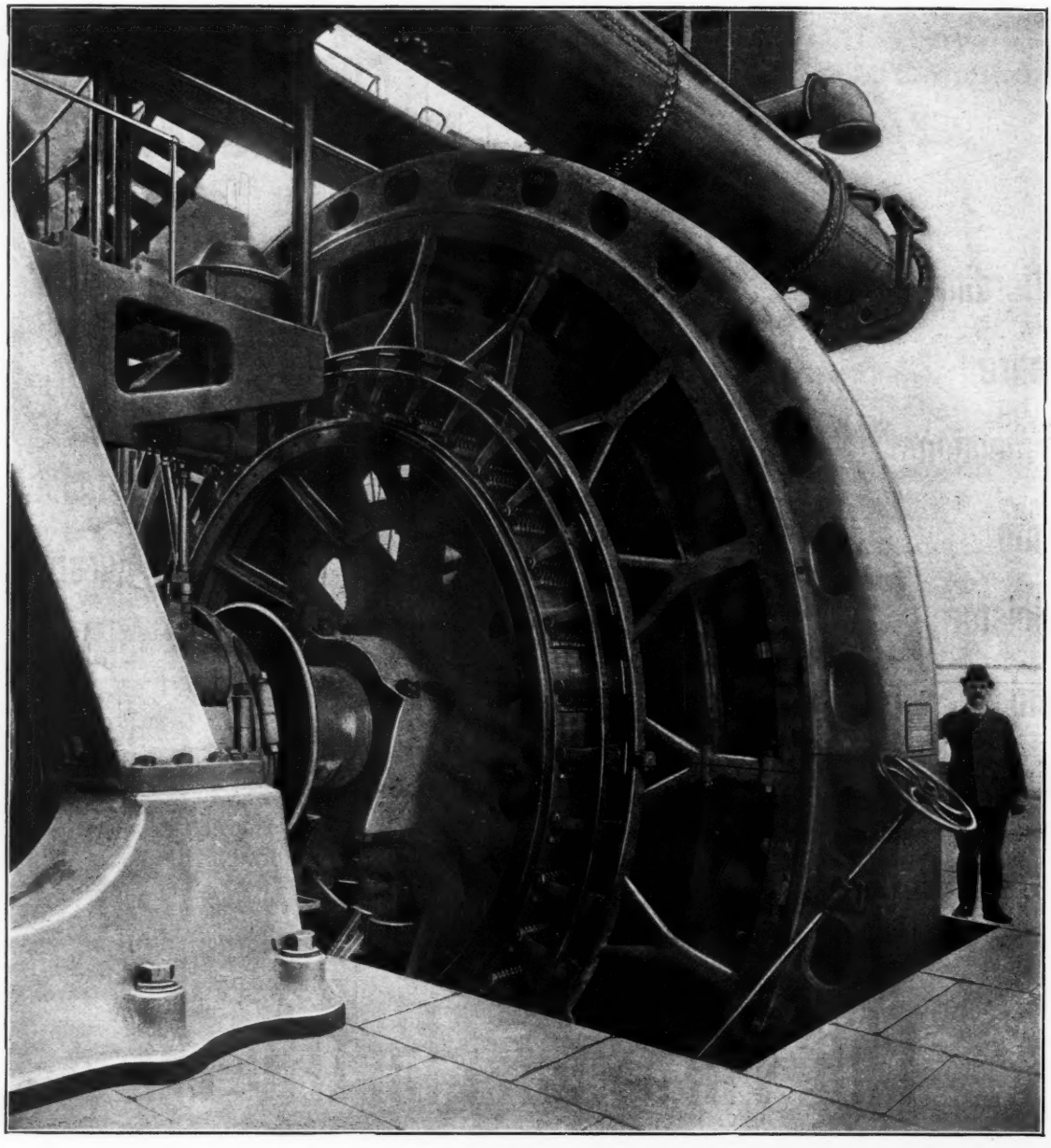

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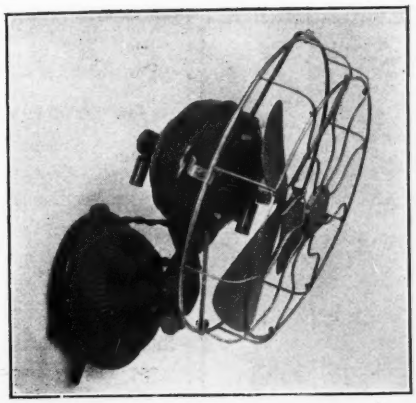

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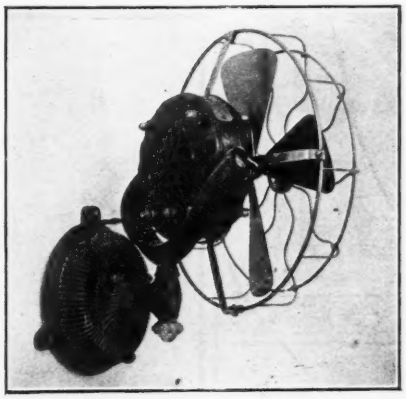

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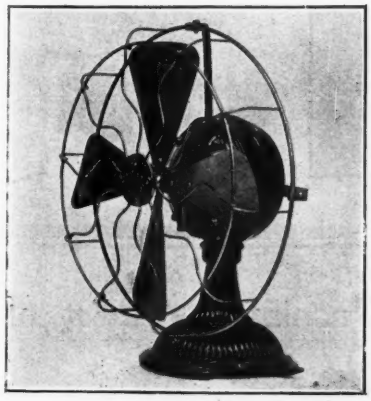

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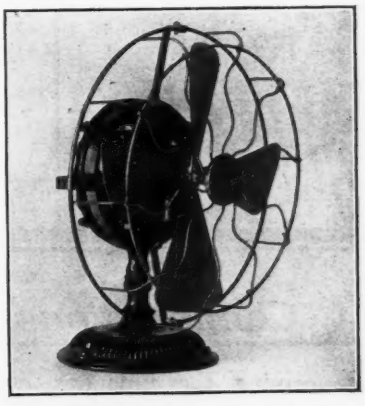

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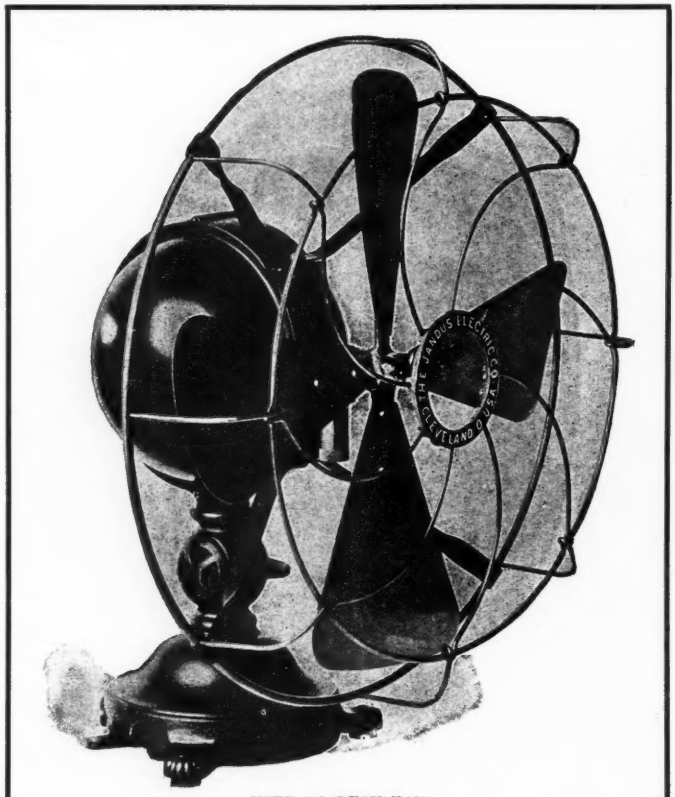

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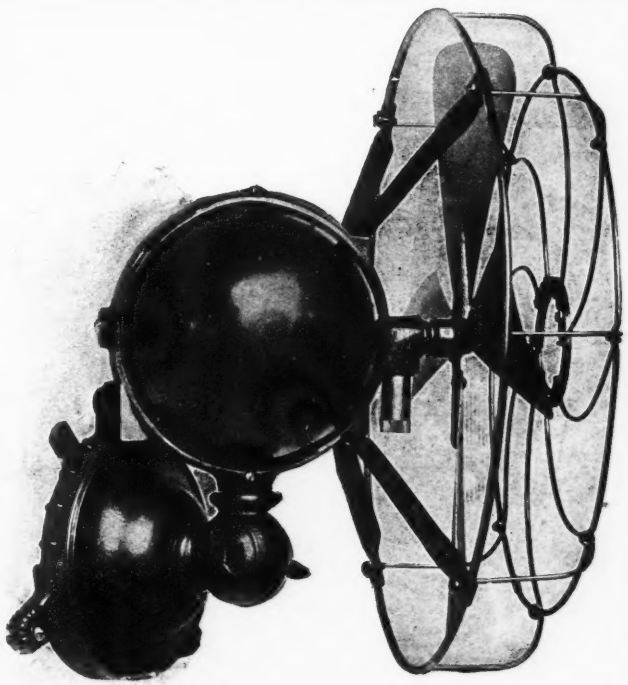

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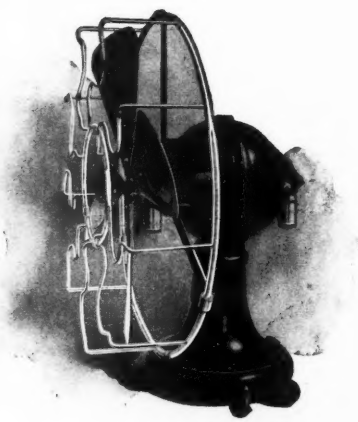

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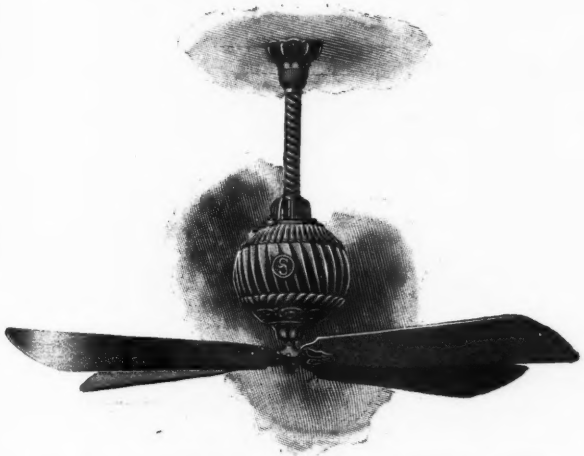
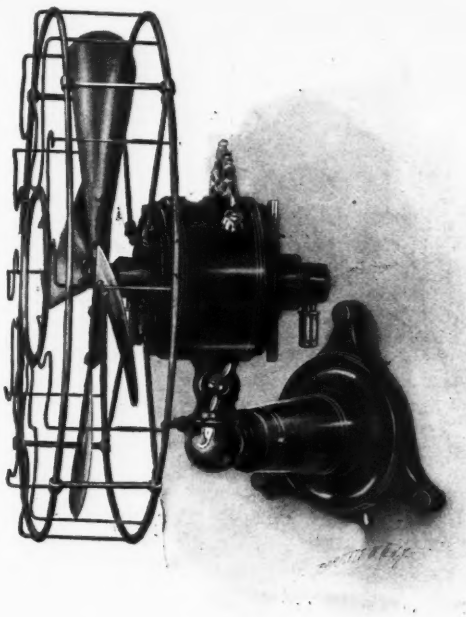


STYLE A—CEILING FAN MOTOR WITH SWITCH.



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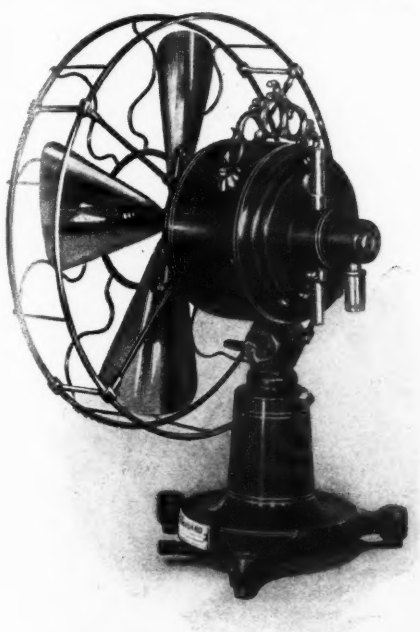
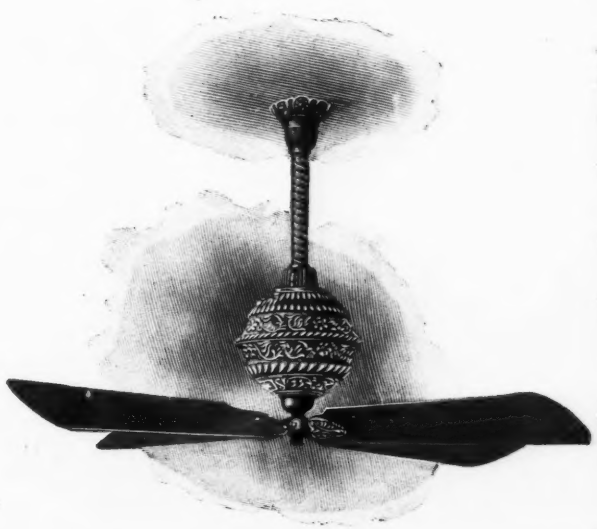
They embody the concrete result of ten years' study and experience in catering to the American fan trade.



12-INCH DESK FAN MOTOR.



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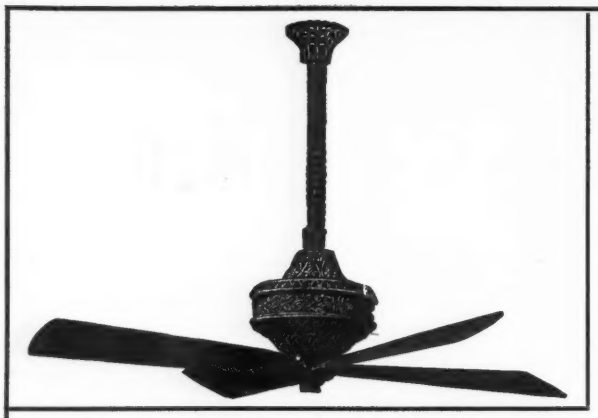

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FOR DIRECT CURRENT ONLY
Ceiling, Desk, Wall, Column
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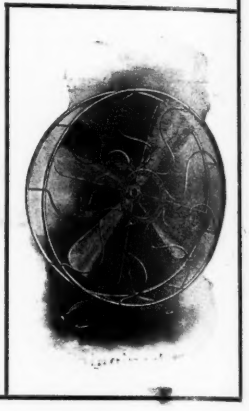

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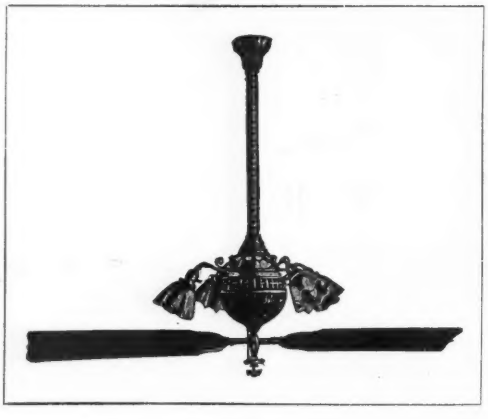

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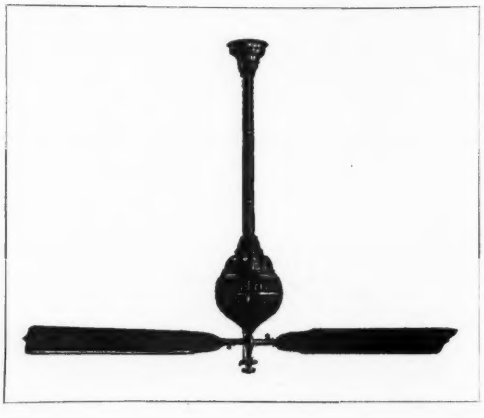

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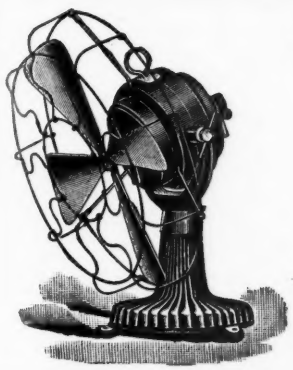

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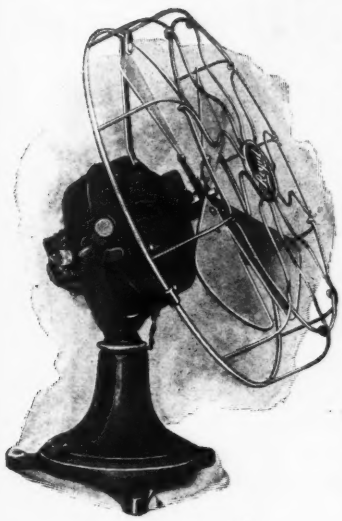

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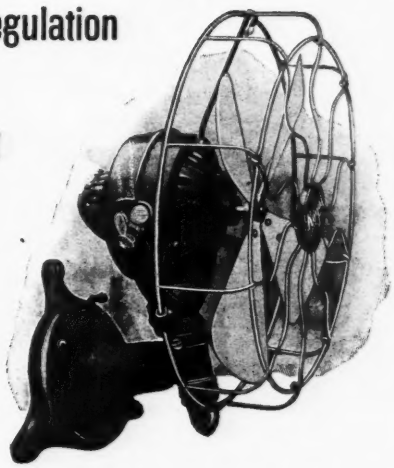

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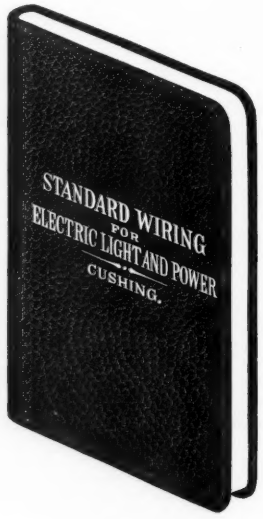

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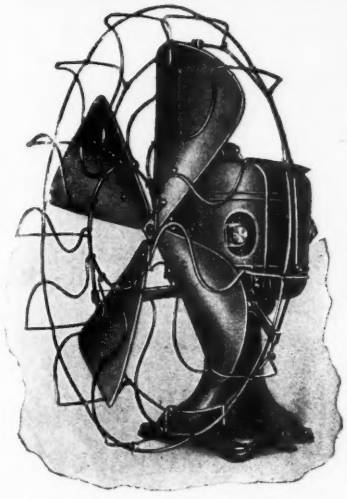

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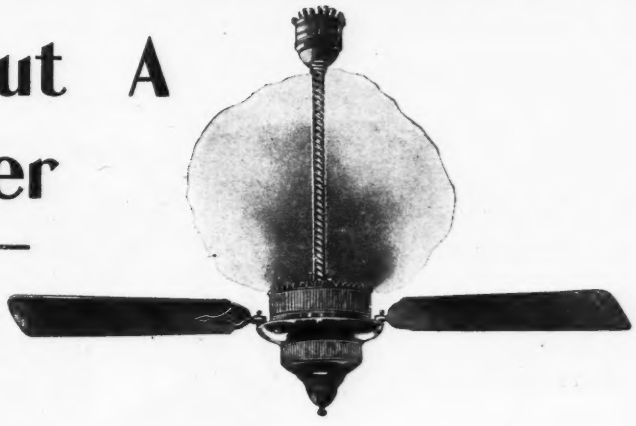

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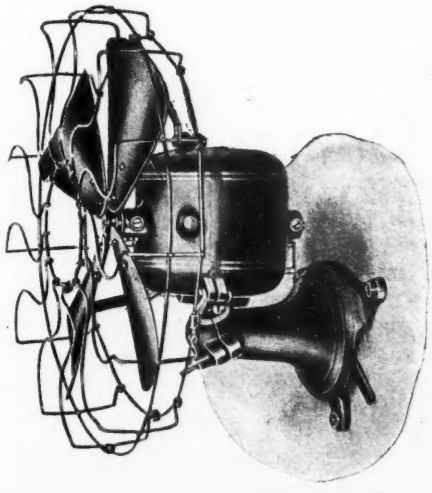

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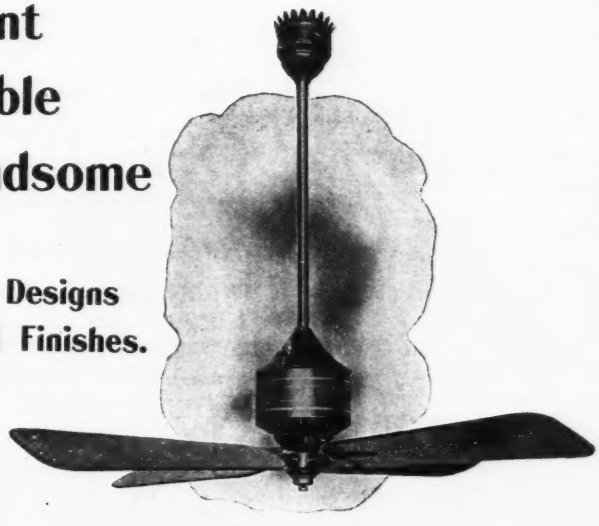

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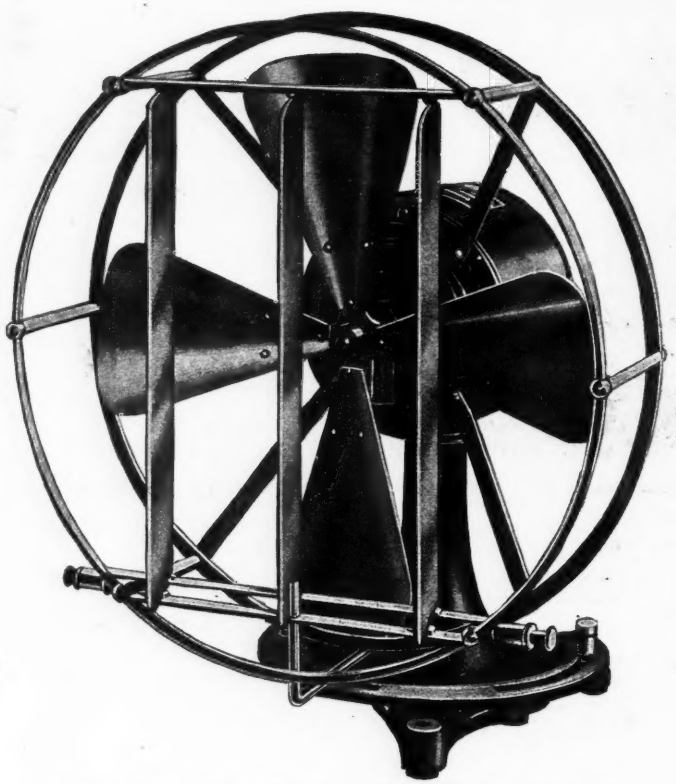

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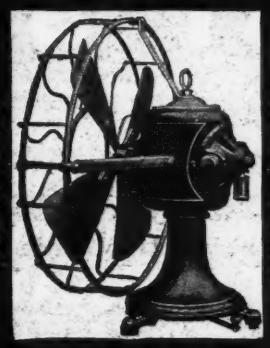
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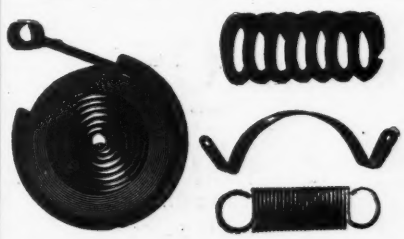
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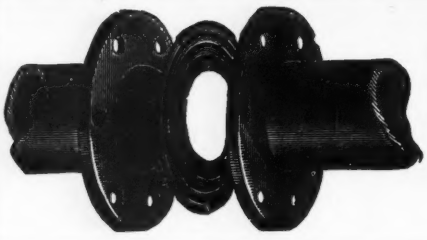

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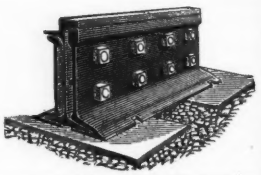

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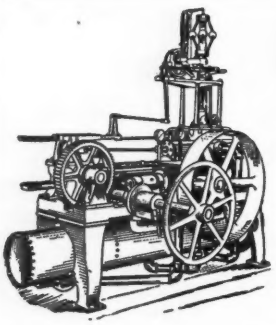

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Gate Open	Head	Rev. Pr. Min.	Cu. Ft. Pr. Sec.	Horse Power	Per Cent
Full	15.60	144.00	172.69	240.97	82.03
⅞	15.04	138.12	155.08	223.61	84.53
¾	15.11	127.67	133.24	191.06	83.68
⅝	15.88	131.50	112.65	162.80	80.25
½	16.47	126.87	90.04	127.73	75.95

Test of a 35 in. Samson, Feb. 1, '97

Gate Open	Head	Rev. Pr. Min.	Cu. Ft. Pr. Sec.	Horse Power	Per Cent
Full	15.29	194.35	102.02	143.44	81.08
⅞	16.56	187.75	92 15	146.73	84.78
¾	17.33	178.50	83.95	138.40	83.88
⅝	17.54	176.40	68.82	109.64	80.09
½	17.68	168.50	57.69	88.14	76.19

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ROBERT G. ELLIOTT,
Elec. Engr., Clinton Prison, Dannemora, N. Y.

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While engaged as a school teacher, I enrolled for the Steam Engineers' Course of the International Correspondence Schools, Scranton, Pa. I soon accepted a position as assistant superintendent of the Jersey Shore, Pa., electric light plant. Soon after completing my first Course, I enrolled for an Electrical Course, and have since received two promotions. The last promotion was to the position of manager, with a salary nearly double what I received as a teacher.

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Send for free circular of the course that interests you.

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The Future of the

THIS issue of the ELECTRICAL REVIEW is largely devoted to remembrance of the past. The story of the twenty years which its history now includes is told at length elsewhere. It is proposed to speak here of the future.

It is recognized that electrical engineering and its allied arts are progressing swiftly and almost immeasurably. To keep pace with this development, to typify each phase of advance, to chronicle faithfully passing achievement, to comment fairly upon all that is done and said, to suggest new lines of thought and new avenues of growth—this is the function of the ELECTRICAL REVIEW. To the discharge of this high duty to its clientele it brings the best intelligence it can command and the most faithful effort.

To cover all the multitudinous detail of the advancing art necessitates a wide field of endeavor. Some idea of the extent of this field may be had from a glance at the opposite page.

There is shown the topics that will be discussed by the ELECTRICAL REVIEW during this and succeeding years.

Electrical Review

- **Science**
  - Physics
  - Chemistry
  - Meteorology
  - Therapeutics
  - Schools
  - Miscellaneous
- **Traction**
  - **Street Railways**
    - Tracks
    - Equipment
    - Rolling Stock
  - **Heavy Railways**
    - Tracks
    - Equipment
    - Rolling Stock
  - **Power**
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    - Hydraulic
    - Generators
    - Switchboards
    - Buildings
  - **Systems**
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    - Polyphase
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  - **Substations**
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    - Converters
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    - Transformers
    - Switchboards
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    - Transformers and Rectifiers
    - Appliances
  - **Incandescent**
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    - Wiring
    - Generators
    - Installations
    - Systems
    - Appliances
  - **Other Systems**
    - Nernst
    - Vacuum Tube
    - .....
- **Power Transmission**
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  - Lines
  - Substations
  - Transformers, etc.
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    - Automatic
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    - Electrical Furnace
    - Aluminum
    - Other Metals
    - Refining
- **Automobiles**
  - **Electric**
    - Batteries
    - Motors
    - Miscellaneous
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    - .....
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    - Descriptions
    - New Methods
    - Shop Management
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    - Wire
    - Cable
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    - Other Instruments
    - .....

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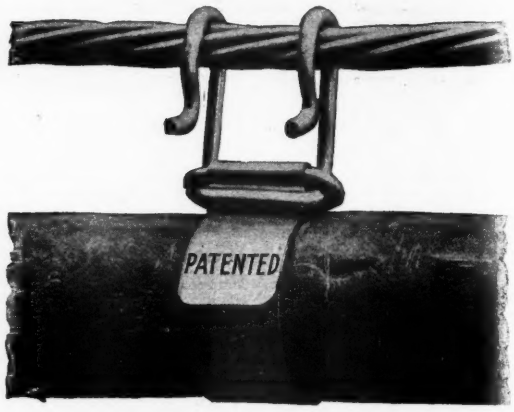

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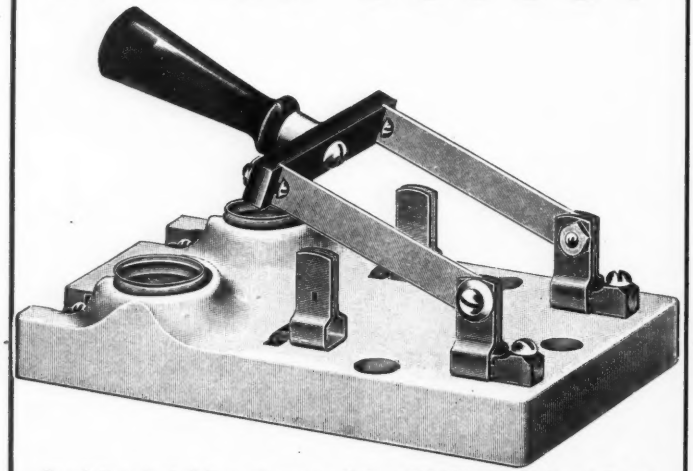

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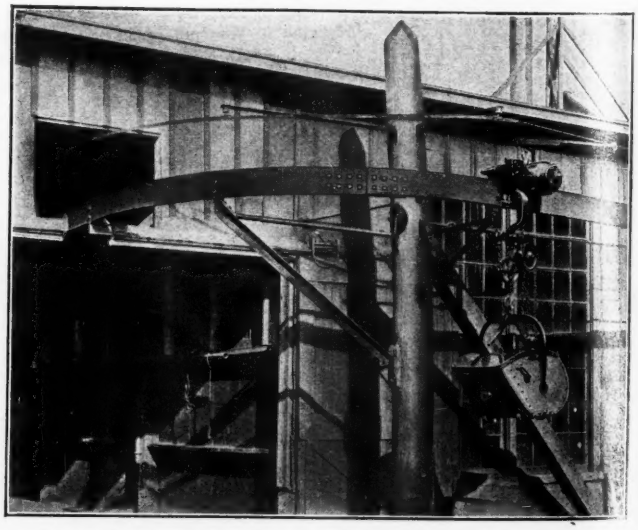

Upon closing the switch, the telpher with the loaded bucket passes to the end of the line, automatically dumps, reverses and returns. One movement only; i. e., closing of the switch. NO SKILLED OPERATOR REQUIRED.

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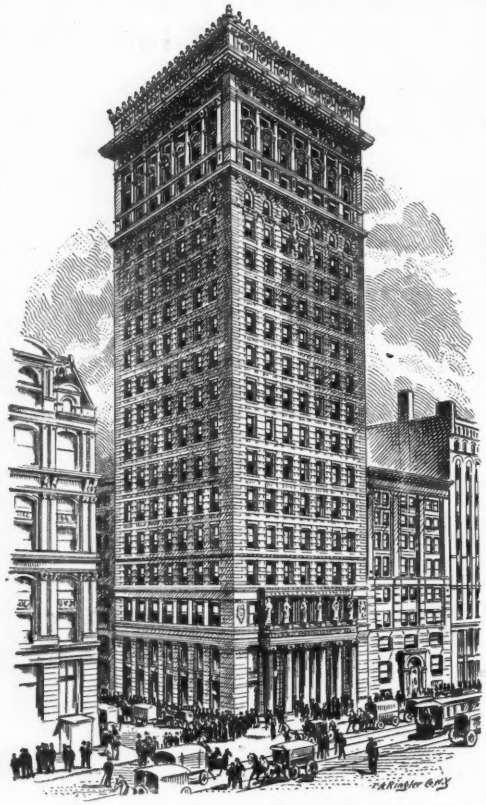

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STATEMENT, DECEMBER 31, 1901

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LIABILITIES (including Reserve, $591,552.89) 885,961.00

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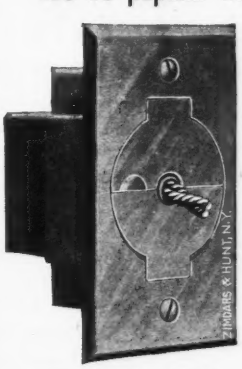

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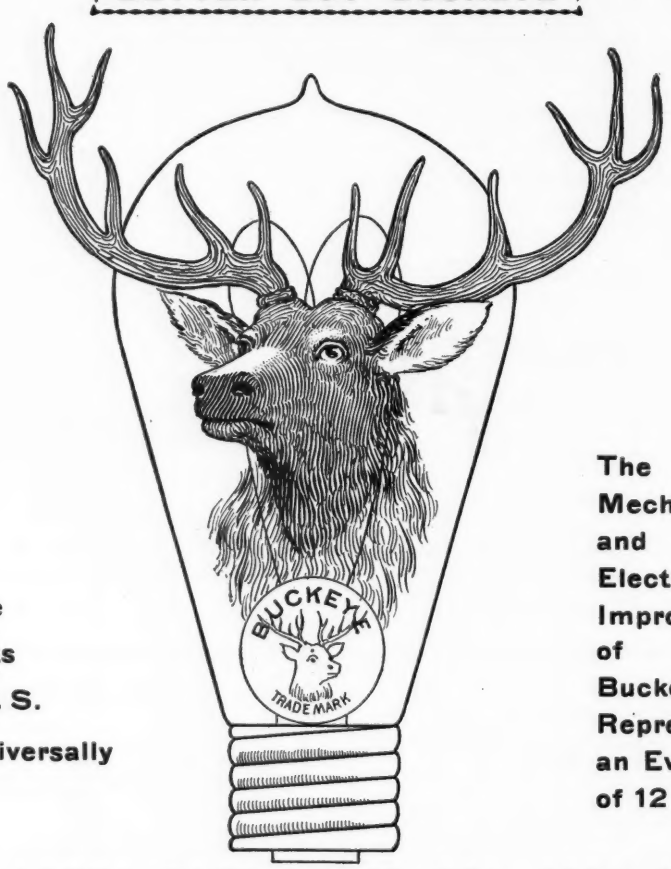

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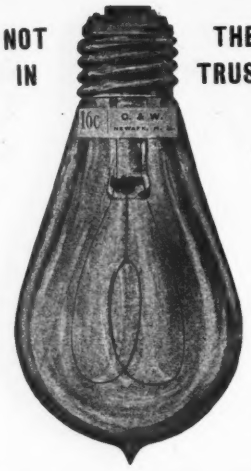

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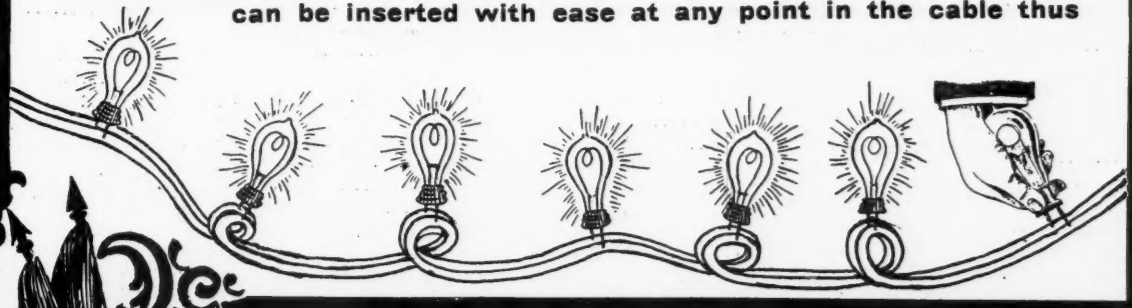

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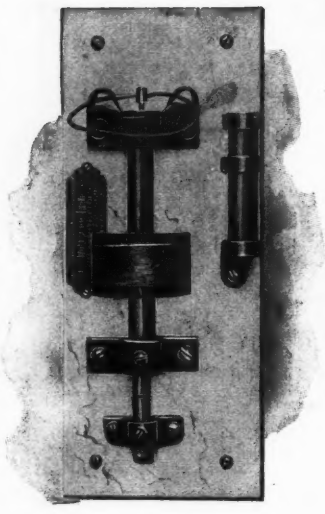

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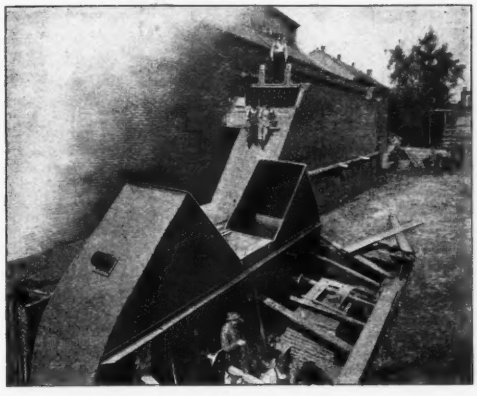

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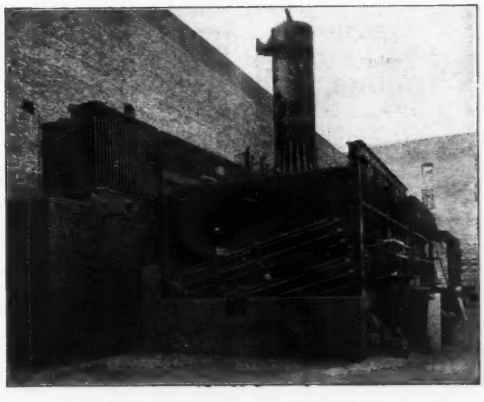

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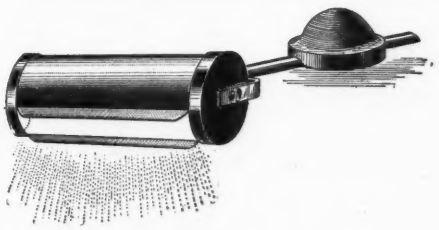

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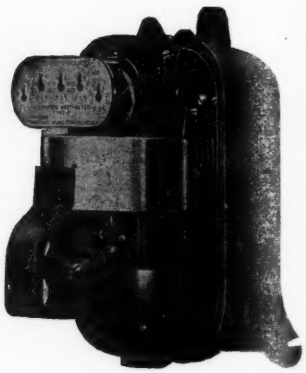

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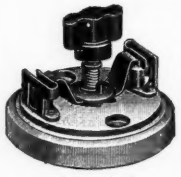

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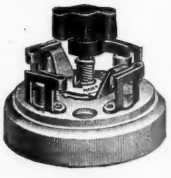

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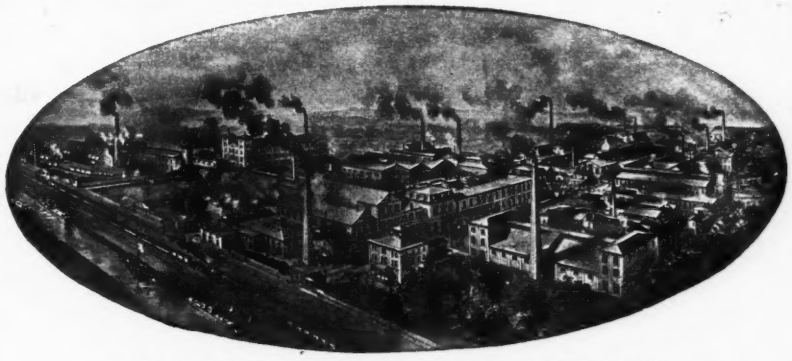

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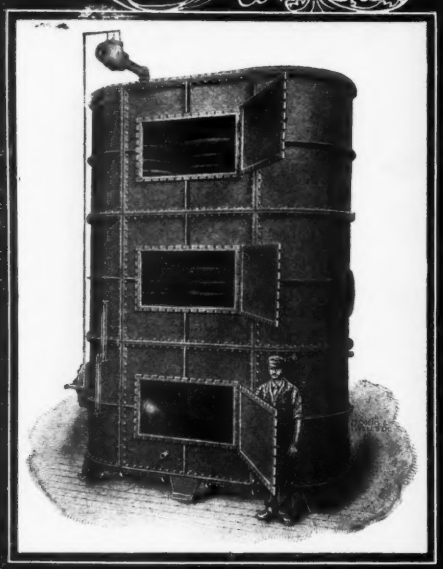

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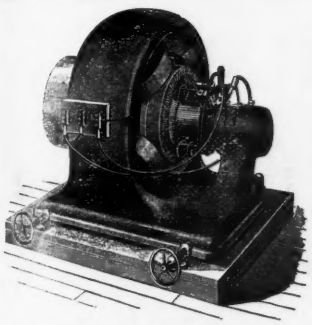

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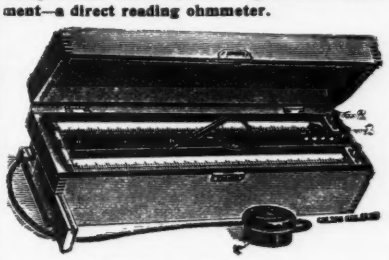

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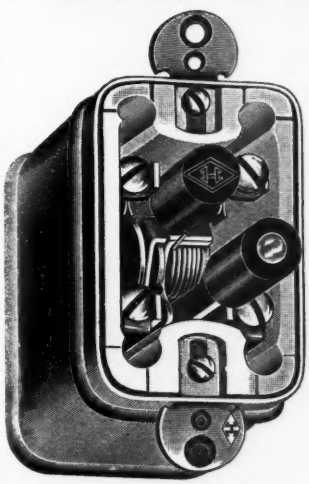

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Catalogue free on request.

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Stephen Girard Bld., Philadelphia

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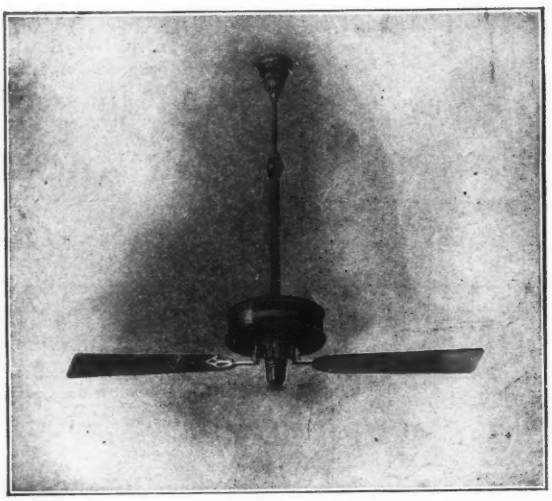

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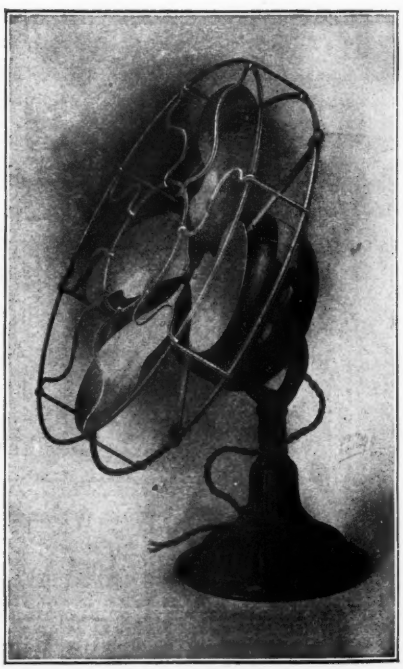
Emerson
Alternating Current
DESK AND CEILING
FANS

All Models and Sizes for Any Voltage or Alternation

Guaranteed free from all electrical and mechanical defects ❧ Fitted with Parker noiseless blades ❧ The only perfect Alternating Current Fan Motor on the market ❧ Fitted with half-inch hardened steel shafts ❧ ❧ ❧



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Western Electrical Supply Co.

CATALOGUES, PRICES, ETC., ON APPLICATION.

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BEFORE BLOWING

"D. & W." Bull's-Eye Indicator

An absolutely FLASHLESS device indicating the blown fuse instantly

AFTER BLOWING

WATCH THE "TARGET" ON THE LABEL OF THE FUSE

WRITE FOR PRICE LIST AND CIRCULARS

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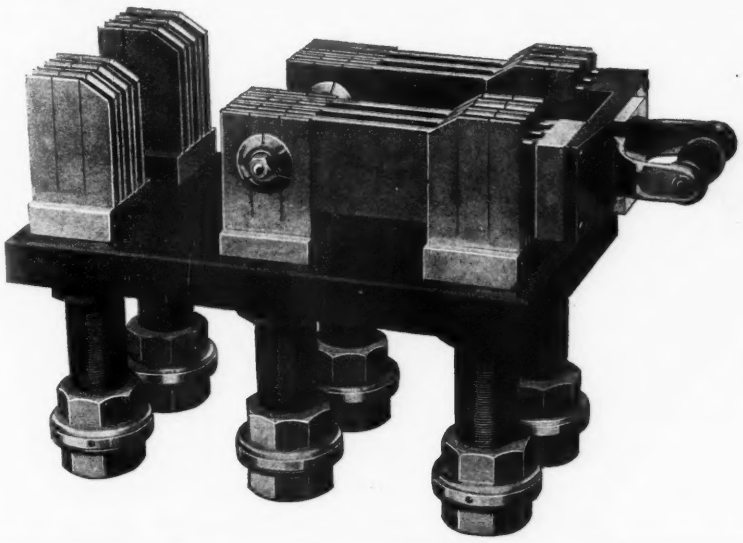

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Switches and Switchboards

Albert J. & M. Anderson Mfg. Co.

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Graphite Resistance.

Graphite Resistance in Rods, Tubes or otherwise. Any resistance wanted—one ohm to one million ohms. Write for particulars.

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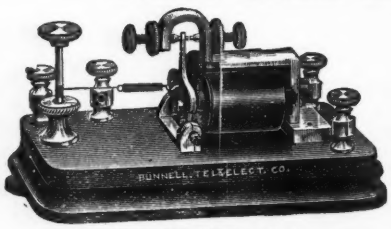
FACTORIES, NEW YORK CITY AND MILFORD, CONN.

Manufacturers of

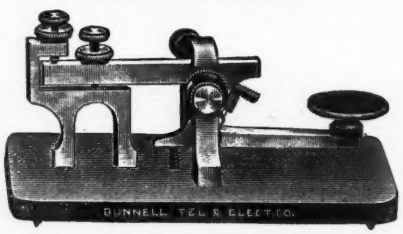
TELEGRAPH, TELEPHONE, RAILWAY AND ELECTRICAL SUPPLIES

Announcement.

We have purchased the Entire Plant, Good Will, Machinery and Patents of the National Electrical Mfg. Co., of Milford, Conn., and will continue the manufacture of District Messenger Call Boxes, Fire Alarm Boxes and Apparatus, Burglar Alarm and Watchman's Boxes, etc., etc., making improvements in every department, with new and up-to-date machinery, expert workmen and the best materials. We assure our patrons low prices, consistent with the class of goods we furnish, and prompt delivery of all orders placed with us.

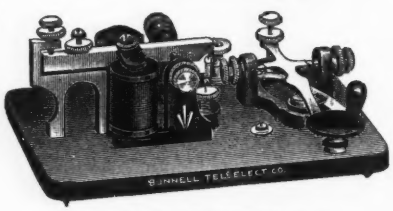


New Form Pony Relay, $1.85

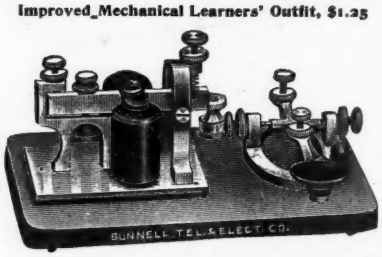


Improved Mechanical Learners' Outfit, $1.25

★ Catalogue of Instruments or Learners' Manual free on receipt of postage. ★



Learners' Latest Instrument, $1.50
Cut complete with Battery Wire, etc., $2.50



Giant Combination Set, for Private Lines, $2.50

★ Every Instrument covered by Patents of Jesse H. Bunnell, deceased, is made by us. ★

Bunnell

CLASSIFIED INDEX

(*Continued from page 60.*)

Adjusters, Incandescent Lamps.
Incandescent Electric Light Manipulator Co.

Alternators.
General Electric Co.
Warren Electric Mfg. Co.
Westinghouse Electric & Mfg. Co.

Annunciators.
Bunnell Telegraphic & Electric Co.
Bunnell & Co., J. H.
Ohio Electric Works.

Batteries, Primary.
Booker Carbon Battery Co.
Bunnell Telegraphic & Electric Co.
Bunnell & Co., J. H.
Burnley Battery & Mfg. Co.
Edison Mfg Co.
Ohio Electric Works.

Batteries, Storage.
American Battery Co.
Electric Storage Battery Co.
Gould Storage Battery Co.
Helios-Upton Co.
Reuterdahl Electric Co.
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Bells.
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Bunnell & Co., J. H.
Ostrander & Co., W. R.
Western Electric Co.

Belt Dressing.
Dixon Crucible Co., Joseph

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Cabling Machines.
New England Butt Co.

Carbons.
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Alphons Custodis Chimney Construction Co.

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C. W. Hunt Co.

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Forest City Electric Works.

Commutator Lubricant.
Allen & Co., L. B.
Anchor Electric Co.

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Marshall, Wm.

Conduits.
American Vitrified Conduit Co.
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Osburn Flexible Conduit Co.
Sprague Electric Co.
Wyckoff Creosoting Co.

Connectors and Terminals.
McIntire Co., The C.

Construction.
New England Engineering Co.

Construction Supplies.
T. H. Brady.

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Central Electric Co.
Central Mfg. Co.
Klein & Son, Mathias.
Lindsley Brothers Co.
Standard Pole & Tie Co.

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Bullock Electric Mfg. Co.
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Bunnell & Co., J. H.
Central Electric Co.
Crocker-Wheeler Co.
Dustin, Chas. E.

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Gen'l Incandescent Arc Light Co.
Hobart Electric Mfg. Co.
Lincoln Electric Co.
Milwaukee Electric Co.
Ohio Electric Works.
Robbins & Myers Co.
Sprague Electric Co.
Stanley Electric Mfg. Co.
Thresher Electric Co.
Wagner Electric Mfg. Co.
Warren Electric Mfg. Co.
Western Electric Co.
Westinghouse Electric Mfg. Co

Electric Locomotives.
General Electric Co.

Electric Heaters.
American Electrical Heater Co.
Simplex Electrical Co.

Electric Lighters.
Ohio Electric Works.
Stanley & Patterson.

Electrical Instruments.
Badt & Co., F. B.
Bossert Electric Construction Co.
Bullock Electric Mfg. Co.
Bunnell Telegraphic & Electric Co
Bunnell & Co, J. H
Central Electric Co.
General Electric Co.
Gen'l Incandescent Arc Light Co.
Keystone Electrical Instrument Co.
Machado & Roller.
Ohio Electric Works.
Pignolet, Louis M.
Sage & Bro., F. B.
Wagner Electric Mfg. Co.

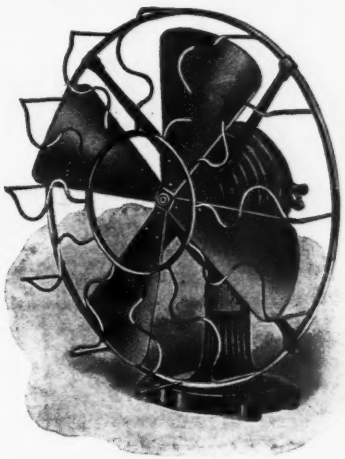
(*Continued on page 106.*)

The Fan of the Year is . . . .

The Colonial

The Desk and Bracket Type are Swivel and Trunnion Frame, beautifully Enameled, Fan and Guard N. P. and Polished Brass finish, three speeds. It runs finely without heating, and gives a strong breeze.

The Ceiling Fan is a new design, one finish, fancy brass. The switch comes out, so that in shipping it can not be broken.



Send for Catalogue and Price List.

J. JONES & SON, Manufacturers and Dealers in Electrical Goods. 64 CORTLANDT STREET, NEW YORK CITY.

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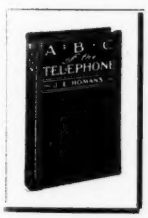

All about the Telephone

A • B • C of the TELEPHONE

A PRACTICAL TREATISE

By J. E. HOMANS, A. M.

352 pages. 269 illus. size, 5x7½ inches with generously good binding

Price One Dollar. Postpaid to any Address

Owing to the great growth of the telephone industry during the past few years, and in response to the demand for a comprehensive book giving a clear, terse idea of the different principles governing the construction, installation, care and management of the various telephones and their appliances, the A B C of the Telephone has been compiled. It is written in a most clear and careful style, and aims to give a complete review of the subject of telephony from the first invention to the most recent improvements.

No expense has been spared in gathering valuable information, and it has been the aim of the author to make this treatise the most complete elementary book ever written on this subject for the practical electrician, wireman, lineman, engineer, and all persons interested in this great achievement of modern science.

Electrical Review Publishing Co.

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INVESTMENT STOCKS AND BONDS

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ELECTRICAL STOCKS

FOR CASH OR MARGIN

MEMBERS OF THE NEW YORK STOCK EXCHANGE
TELEPHONE "1893 BROAD"

Twentieth Anniversary Number of the Electrical Review

TABLE OF LEADING ARTICLES.

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Frederick P. Fish	Samuel Insull	Frank H. Phillips	George G. Ward

Edwin R. Weeks George Westinghouse Alden M. Young

LAMPS. THE SPECIAL KIND YOU WANT AT THE PROPER PRICE

One maker of *lamps* meets the varying demand by producing not only the highest-class *lamp* made (Double Filament Type) but also the regular grades of the cheaper makers.

If you are dealing with this one producer you can get the special kind you want at the proper price for that kind.

There is an advantage in buying the cheaper *lamps* from the manufacturer of the highest-priced goods. His knowledge of quality is absent in the cheaper factories.

There is just one page of advertising aimed right at you among the six that follow. It will hit you, too.

II. **TO THE**

CONTRACTOR

Here is a Multiple Lamp that Uses Only 10 Watts.

Lamp-letter signs are popular. This is the dull season. Work up a business that is "easy." A sign using 100 lamps here shown consumes but one kilowatt. The lighting of the sign costs 10c. an hour, or less. There are a dozen customers waiting for you.

This lamp is 2 c. p. We make them in 4 c. p. (18 watts) and 6 c. p. (24 watts). All bases moisture proof.

Suggestions: Try Army and Navy Lamps and save claims for defects. Extra long life. The price is right.

Try Imperial High-Volt Lamps on your next work. They cannot short-circuit. See page 5 in this advertisement.

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FACTORY, MARLBORO, MASS.

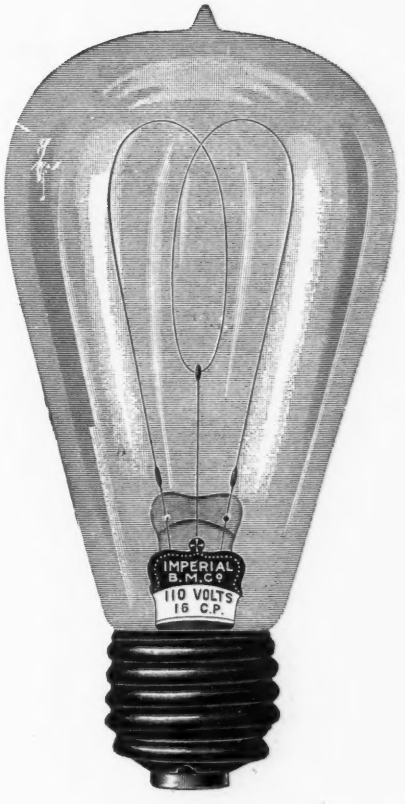
TO THE DEALER

A poor lamp loses supply trade; a good lamp keeps it—brings more. Buy even your cheaper lamps from an unquestioned source. Make your purchases where the largest Central Stations are buying. Three grades to meet all demands, but the cheaper lamps are cheaper because one filament is less expensive than two. They get Double Filament care in manufacturing.

Some customers want the best—some the cheapest—some both. Be ready to serve everyone.

Suggestions:

1. Imperial Double-Filament Type, (20c).
2. Imperial Oval-Anchored Type, (18c).
3. Army & Navy Type, (17c).
4. 2, 4, and 6 c. p. sign lamps; consume less watts than any competitor.
5. High-Volt (double-filament) lamps, the only type that is moisture and short-circuit proof.
6. Regular high-volt lamps.
7. Double line of Globular lamps.
8. Complete line of Candelabra lamps.
9. Complete line of Battery, Dental, and Surgical lamps.



Bryan-Marsh Oval-Anchored Lamp. Guarantees of Candle-Hours, 4 per cent. in excess of the nearest competitor.

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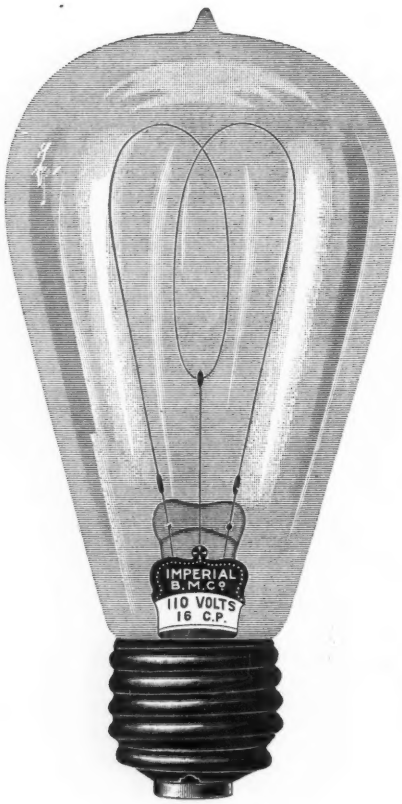
IV. **TO THE**

STREET RAILWAY PLANT



Bryan-Marsh
Street Railway
Lamp.
Electrically the Best
and
Mechanically the
Toughest Filament Made.

Do you realize that your trouble with short-lived lamps is caused by the mistakes of the manufacturer, even though he makes good lamps? We can aid you by a specification that means better satisfaction with any lamp. When we couple that with a filament that is tough enough to wrap around your finger, our lamps must please you.

Large railway systems, who watch lamp renewals carefully, patronize us. Sometimes the cut in yearly renewal charges has been large—you wouldn't believe how large without the facts.

Suggestion: Have us prove our claims. You name the way you want it done.

BRYAN-MARSH COMPANY

136 LIBERTY STREET, NEW YORK.

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PHILADELPHIA, PA. 1338 Real Estate Trust Bldg.
BOSTON, MASS. 315 Exchange Bldg.

FACTORY, MARLBORO, MASS.

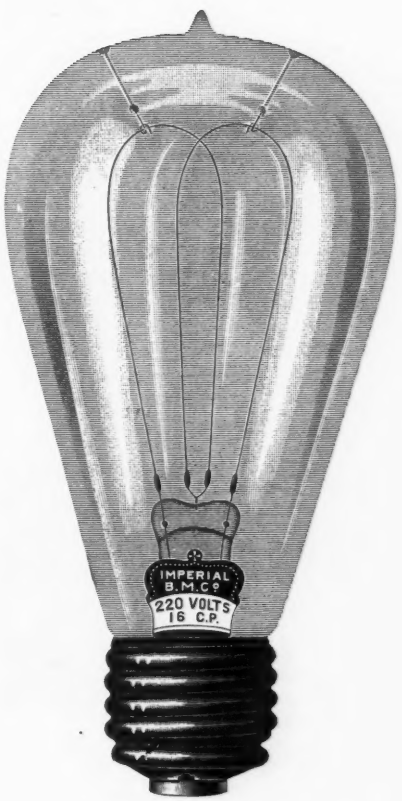
TO THE ELECTRICAL ENGINEER

Our experience in meeting arduous conditions is known. If you require economy, Double-Filament Lamps will withstand fluctuations impossible with other lamps.

Double-Filament High-Volt Lamps can't short circuit or give trouble from static charges. We first made commercial high-volt lamps.

In all our lamps uniformity, not only initially, but during service, is secured. Your chief care is how the lamp will act when used—not before. We can mail you special literature to establish our claims.

Suggestions: To secure the best results, specify Double-Filament, else your client gets cheaper lamps. Prices and particulars on request. Get our specification pointers.



The original High-Volt Lamp. Let our experience save your trouble. Competitors are still experimenting.

BRYAN-MARSH COMPANY

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FACTORY, MARLBORO, MASS.

VI.

TO THE ISOLATED PLANT

A quick way of testing rival lamps.
The dread of the poor lamp maker.
Tests unerringly the waste of power.

How to operate:

Screw two lamps in the sockets, and close the circuit. Gas will at once rise in the tubes, forcing down the liquid.

The lamp that consumes the most current will generate the most gas, and consequently force the liquid down faster than the more economical lamp does.

Break the circuit when the lowest level in the tube reaches 100 per cent. Note the percentage opposite the highest level in the other tube, which will show the exact difference in percentage of the current consumed.

Check the results by reversing the lamps and repeating.

Have you ever heard of the Compari-Meter? It compares exactly the relative power consumed by two lamps. It proves how dearly you are paying in coal for cheap lamps. We can save you 10% with Special Economy Double-Filament Lamps.

A five dollar bill brings the Compari-Meter and six free samples of the Special Economy Double-Filament Lamps as claim provers.

Suggestions: Why not install that sign? Our 2 c. p. sign lamp takes 10 watts, and a 100-lamp sign takes but one kilowatt; 4 or 6 c. p. if desired. Moisture-proof bases.

Commercial high-volt lamps started with us. Save your trouble by our experience.

BRYAN-MARSH COMPANY

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PHILADELPHIA, PA. 1338 Real Estate Trust Bldg.
BOSTON, MASS. 315 Exchange Bldg.

FACTORY, MARLBORO, MASS.

TO THE CENTRAL STATION

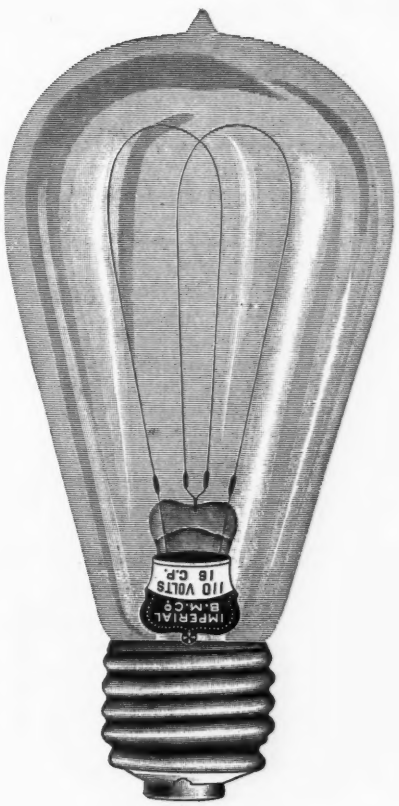
Your interest centers in life and light. Get our facts and figures instead of salesmen's talk or makers' "claims."

Written guarantees that our Double-Filament lamps are highest in useful Candle Hours by 13%. This means 13% better sustained candle-power, 13% longer life, 13% less lamps to buy.

The higher price is economically cheap, as the excess guarantees are double the excess price.

Representative Stations use our lamps. We supply the Oval-Anchored type at competing prices, but we recommend Double-Filament.

Suggestion: Who is likely to give the best advice; the maker of one kind, or the maker of both kinds?



Bryan-Marsh
Double Filament
Type.
The Standard
American Lamp
where *results* are wanted.

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FACTORY, MARLBORO, MASS.

PLATINUM

PLATINUM FOR CONTACT POINTS IN ELECTRICAL INSTRUMENTS.
PLATINUM FOR TELEPHONES. PLATINUM FOR ELECTRICAL INSTRUMENTS.

We sell PLATINUM in any quantity, either large or small. We buy PLATINUM, or anything containing PLATINUM, in any quantity.

FOR INCANDESCENT LAMPS AND EVERYTHING ELSE.

BAKER & CO.

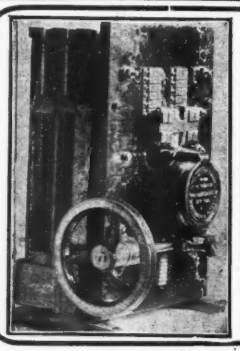
MANUFACTURERS OF PLATINUM IN ALL SHAPES.

Newark, N. J. New York Office, 120 Liberty St.

FLEXIBLE METALLIC CONDUIT STEEL ARMORED CONDUCTORS

These products represent one of the latest and most radical advances in the art of electric wiring. They are in great demand because of their superior qualities. Our conduits and appliances are described in Catalogue No. 4046.

SPRAGUE ELECTRIC CO. GENERAL OFFICES: 527-531 WEST 34th STREET, NEW YORK



AUTOMATIC REVERSIBLE ELEVATOR CONTROLLER.

Construction absolutely fireproof. Tubular resistance of ample capacity. Heavy brass contacts renewable from the face of the slate. Powerful ratchet movement operated by eccentric. Graphite bearings requiring no oil. Slow speed of 300 R. P. M. Suitable for direct connection to elevators, lifts, hoists, etc., or any service requiring a rapid start, stop, and reversal of the motive power.

AUTOMATIC SWITCH COMPANY,
131 LIBERTY STREET, NEW YORK, N. Y.

NEW VACUUM REGULATOR
For use in
X-RAY WORK
With the GE Tube.

Eliminates all liability to puncture.
Enables one tube to do the work of three.
Gives a glow as steady as an incandescent lamp.
Miniature Incandescent Lamps and Sockets.
Dewar Bulbs for Liquid Air.

EDISON DECORATIVE & MINIATURE LAMP DEPT.,
General Electric Co.,
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2

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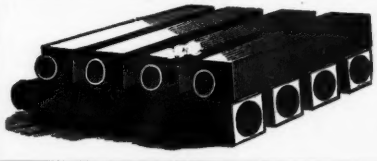

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[Specially reported for this journal by E. S. Duvall, solicitor of patents, Loan and Trust Building, Washington, D. C. Copies of any patent may be secured for 10 cents each.]

ISSUED FEBRUARY 4, 1902.

692,236 Electromechanical device for electric traction; E. Cantono, Rome, Italy.

692,248 Musical stringed instrument; G. H. Davis, New York, N. Y.

692,250 Calling apparatus for telephone lines; W. Dean, Chicago, Ill.—A telephone line and means for producing current therein, of a bridge of the line having a winding of an induction-coil, a relay and a condenser included serially therein, a telephone switch and a shunt of the relay and condenser controlled thereby, said shunt including a transmitting telephone and a circuit controlled by the relay.

692,260 Incandescent lamp; H. Garwood, Ottawa, Ohio.

692,318 Coin or metal detector; F. E. J. Litot, Pittsburgh, Pa.

692,348 System of electrical distribution; E. B. W. Reichel, Steglitz, Germany.

692,352 Controlling apparatus for electric motors; W. J. Richards, Milwaukee, Wis.

692,395 Rail-bond; M. F. Whiton, Hingham, Mass.

692,413 Electric heater; J. F. Bachman, Vienna, Hungary.

692,423 Electric signal; C. Budke, Jr., St. Louis, Mo.

692,426 Transmitter for Morse alphabet and printing telegraphy; L. Cerebotani, Munich, Germany.

692,427 Electric switch; J. D. Clay, New York, N. Y.—A pulley having a cord, band or chain secured thereto, a ratchet wheel adjacent to the said pulley, a shaft common to said pulley and wheel, means coacting between said shaft and pulley for returning said pulley, a pawl on the pulley engaging the ratchet wheel, a switch

(*Continued on page 94.*)

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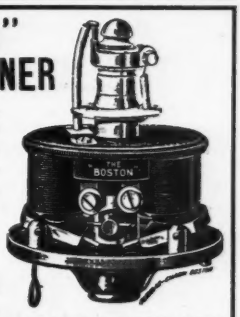
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PATENTS.

(*Continued from page 93.*)

lever, a crank pin on the ratchet wheel, and a link connecting said lever to the crank pin.

692,429 Electric switch; H. J. Cogswell, Hartford, Ct.—An electric switch having insulated circuit terminal posts, pivoted blades, each blade being adapted to connect and disconnect a pair of terminals, a rotatable disc, links connecting the blades with the disc, a crank arm, a link connecting the crank arm with the disc, and means for intermittently rotating the crank arm.

692,432 Apparatus for the prevention of sparking and arcing in electric circuits; H. H. Dow, Midland, Mich.

692,433 Electric accumulator; C. P. Elieson, Paris, France—An electric accumulator plate comprising a central conducting-core, and strips of thin lead alternately flat and corrugated, attached at one end to each side of the core, and free at their other end.

692,458 Electric lamp socket; S. A. Koltonski, Boston, Mass.

692,471 Electric annunciator; E. B. Overshiner, Chicago, Ill.

692,475 Automatic circuit-breaker; C. Reynolds, Columbus, Ohio.

692,507 Reversible galvanic battery; T. A. Edison, Llewellyn Park, N. J.

692,509 Electric clock; M. Fisher, Zurich, Switzerland—A current generator, its armature, an abutment

(*Continued on page 96.*)

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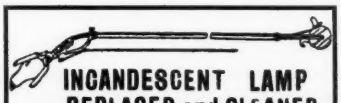
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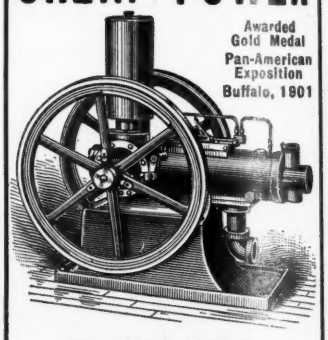
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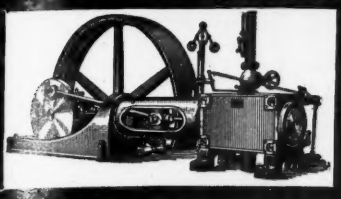

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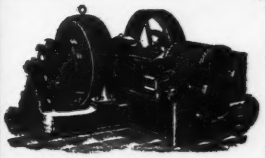

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2—175 K. W., Edison Bipolar, 500 volts.
3—D62, Thomson-Houston Bipolar.
2—90 K. W., Thomson-Houston M. P., 550 volts.
1—100 K. W., Walker M. P., 550 volts.

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1—25 K. W., 120-volt Westinghouse Generator, direct-connected to 9½ x 10 Armington & Sims Engine.
1—500 K. W., General Electric M. P. Generator, 500 volts, direct-connected to 30 x 48 HAMILTON-CORLISS ENGINE, right hand. IN EXCELLENT CONDITION.
1—400 K. W., General Electric Generator, Form H., 525 to 575 volts, direct-connected to 24 x 36 HAMILTON-CORLISS ENGINE, left hand. BRAND NEW, ONLY USED A FEW TIMES.
1—800 K. W. UNIT, CONSISTING OF 2-400 K. W.; GENERAL ELECTRIC GENERATORS 500 volts, and 1 36 x 60 HAMILTON-CORLISS ENGINE, right hand.

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1—36 x 60, Hamilton-Corliss, right hand, speed 56 R. P. M.
1—10 x 12, Buffalo Forge Engine, left hand, centre crank, belted to 24 ft. Buffalo Forge Blower. IN FINE CONDITION.
1—15½ x 15, Armington & Sims.
1—12 x 13, Armington & Sims.
1—13 x 12, New York Safety.
1—18 x 48, George H. Corliss.
1—16 x 42, Greene Engine.
1—22 x 48, Harris-Corliss Engine.
1—9 x 16 x 12, Ball Tandem Compound.

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PATENTS.

(Continued from page 94.)

rigidly connected to the latter and a spring on either side and in the path of said abutment, and means for oscillating the armature.

692,531 Electrolytic cell; E. A. Le Sueur, Rumford Falls, Me.

692,533 Electric signaling device for preventing railway collisions; G. del Monaco, Triest, Austria.

692,553 Telephone repeater or relay; S. D. Sprong, Metuchen, N. J.—An insulated chamber, the interior of which is in a state of partial vacuum, particles of carbon-coated iron particles within the same, circuit connections with said chamber and in circuit with the particles therein, and a magnet in juxtaposition to chamber for normally holding the particles in a fixed relation.

692,579 Electric gong; J. A. Wotton, Atlanta, Ga.

692,580 Annunciator; J. A. Wotton, Atlanta, Ga.

692,591 Detector mechanism for weft-replenishing looms; W. H. Baker, Central Falls, N. Y.

692,625 Sparking igniter for combustible-vapor engines; D. P. Clark, Grand Rapids, Mich.

692,631 Apparatus for electrically dispersing fluids; J. F. Cooley, Boston, Mass.

692,690 Motor for railway devices; H. D. Miles, Detroit, Mich.—A motor box, a casing for hermetically sealing the commutator and brushes of the motor, and clamping devices engaging said casing and said motor box for clamping the casing tightly against the motor box.

692,700 Insulating lining for incandescent lamp sockets; H. T. Paiste, Philadelphia, Pa.

692,737 Static electric machine; H. B. Todd, Meriden, Ct.

692,779 Controlling apparatus for electric motors; F. F. Brush, New York, N. Y.—Main conductors and an electric motor, a main switch controlling the motor circuit, a magnet for operating said switch, a relay switch in the circuit of the main switch magnet, a magnet for operating the relay switch, and a primary switch controlling the circuit of said relay magnet and adapted to be operated by variations in fluid pressure.

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For tickets, itineraries, and other information apply to ticket agents, or to Geo. W. Boyd, Assistant General Passenger Agent, Broad Street Station, Philadelphia.

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1 Engine, 100-H.-P., McEwen Tandem Compound, Non-Condensing.
1 100-H.-P. Horizontal Tubular Boiler.
1 50-H. P. Horizontal Tubular Boiler.
1 Blake Duplex Steam Pump, Injector, Steam Gauges, Piping, etc.
1 750-Light Fort Wayne Alternator, with Exciter, 1,000 Volts, Single-Phase.
1 90-Light Fort Wayne Arc Dynamo, 4 Amperes.
80 800-C. P., 4-Ampere Fort Wayne Arc Lamps.
1 White Marble Alternating-Current Switchboard, with Voltmeters, Ammeters, Ground Detectors, Switches, etc.

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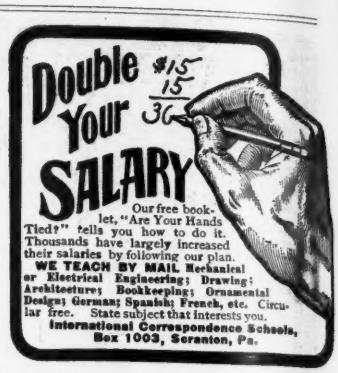

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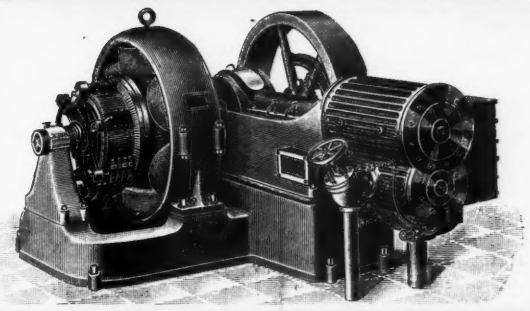

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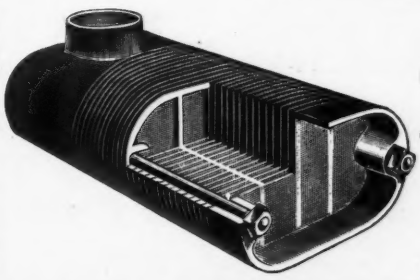

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Managers { W. L. Candee. H. Durant Cheever.

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Operates exchanges in every considerable town in Connecticut, and by its toll lines reaches 160 out of the 168 towns in the State.

Its equipment is exclusively metallic circuits of heavy copper wire and solid back, long-distance transmitters with bipolar receivers.

This Company operates the

Oldest Telephone Exchange in the World,

that at New Haven, which has been continuously operated since the 28th of January, 1878.

EXECUTIVE OFFICES,

New Haven, Connecticut.

One Year's Record
Bell Telephone Company of Buffalo

Territory of Bell Telephone Company—Erie, Niagara, Orleans, Genesee, Wyoming, Livingston and Monroe Counties.

Total net gain in telephone stations in whole territory for vear ending December 31, 1901, **6,546**

ROCHESTER:

Total net gain in Rochester stations for vear ending December 31, 1901, - - - - - **2,037**

A net installation of over 1,000 telephone stations in one month indicates the rapidity of our growth.

The Bell Telephone Company of Philadelphia

(26,000 SUBSCRIBERS)

The Delaware and Atlantic Telegraph and Telephone Company

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Includes—

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Pottstown
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Doylestown
Camden
Trenton
Atlantic City
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Ogontz
Lansdale

These companies connect with each other and with the Long-Distance system of the American Telephone and Telegraph Company. (Over 1,250,000 subscribers)

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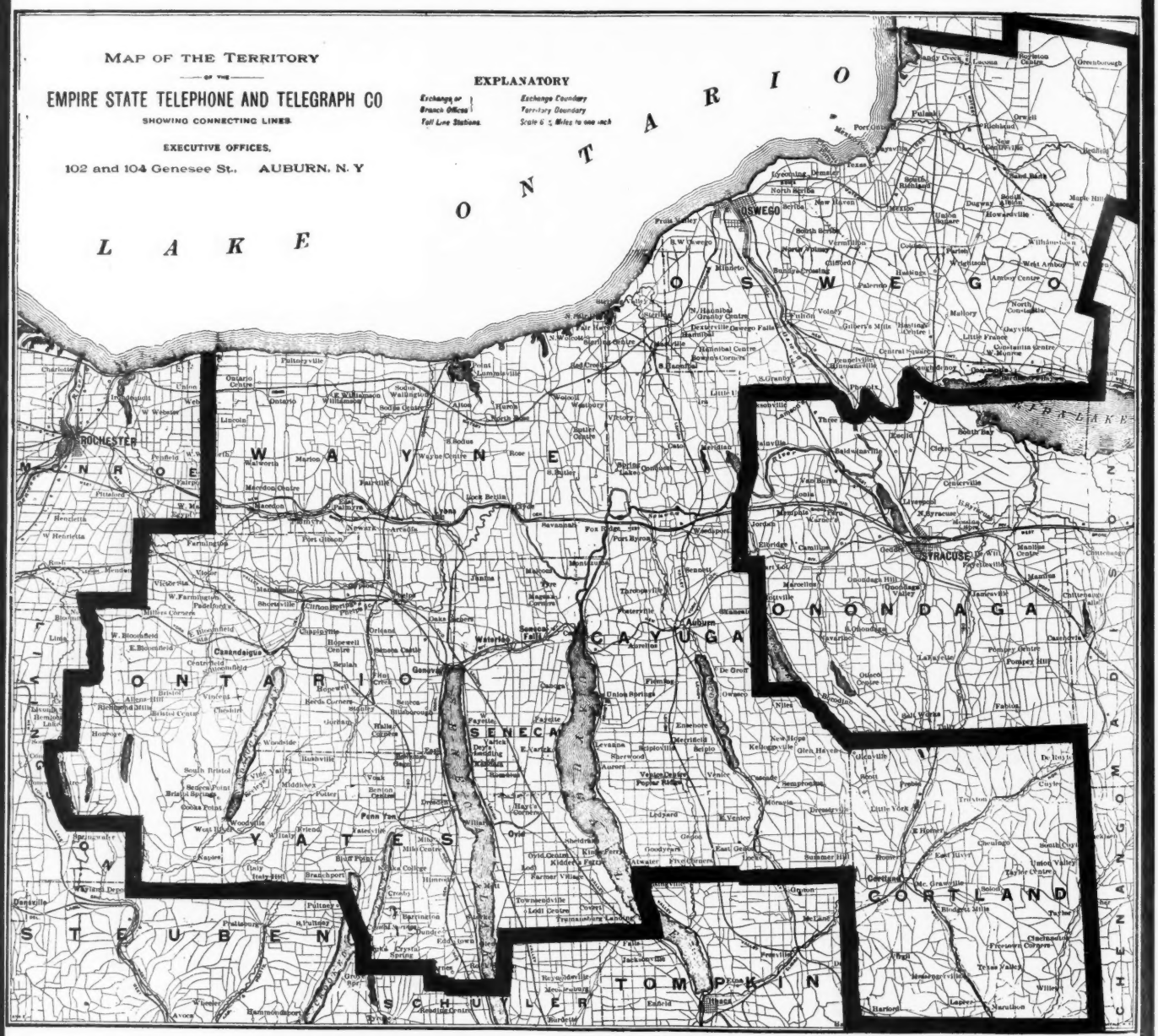
The Empire State Telephone and Telegraph Company

is the licensee of the American Bell Telephone Company for the counties of Cayuga, Seneca, Wayne, Yates, Ontario, Oswego and Cortland in the State of New York. It is the successor of the Bell Telephone Company of Auburn and a number of other companies operating in this territory.

It was organized in June, 1881, by Henry L. Storke, one of the pioneer telephone men of the country, and his associates at Auburn, N. Y. Its original board of directors included the following named gentlemen residing in that city: Wm. Gray Wise, James Seymour, Jr., Dexter A. Smith, George Underwood, Henry L. Storke, and at various periods the Bell Company's interest has been represented by Theo. N. Vail, George L. Phillips, Charles R. Truex, Albert O. Morgan, Robert S. Boyd, David B. Parker and C. Jay French. Subsequent changes in the local representation have been Frederick I. Allen in place of Wm. Gray Wise, deceased, and Nelson B. Eldred, E. H. Avery, C. I. Avery, M. M. Storke and John D. Teller by reason of increase of the board to nine new directors.

Henry L. Storke has been president of the company from the beginning, and Dexter A. Smith vice-president until his death in November, 1900.



George Underwood was secretary from the organization of the company until 1898, when he was succeeded by Murray M. Storke, and James Seymour, Jr., held the office of treasurer continuously from 1881 to 1898, when he resigned by reason of ill health and was succeeded by Charles I. Avery. There have been but three assistant general managers: Jno. S. Reid, F. C. Timpson and Geo. A. Paddock, the present incumbent. C. A. Weeks has been auditor since the organization of that department.

The following are the present officers and directors:

Henry L. Storke, president and general manager; M. M. Storke, secretary and assistant auditor; Charles I. Avery, treasurer; Geo. A. Paddock, assistant general manager; C. A. Weeks, auditor.

Martin Joyce, superintendent Oswego District; Wm. C. Page, superintendent Western District.

Directors: Henry L. Storke, Edward H. Avery, C. Jay French, Charles I. Avery, John D. Teller, Murray M. Storke, Geo. Underwood and Fred. E. Storke.

The company developed its toll line system at an early date, and now has some 900 miles of pole lines connecting all points in its territory, and by the extension of that class of business shows an annual average income per station of all classes of nearly $20.

Its history covers almost the entire period since the telephone ceased to be regarded as a scientific toy and became a constantly increasing business necessity. The management, practically unchanged from the beginning, has passed through all the experimental stages of the industry, from house-top fixtures and grounded lines to the modern metallic circuit and long-distance equipment.

PROVIDENCE TELEPHONE COMPANY

PROVIDENCE, R. I.

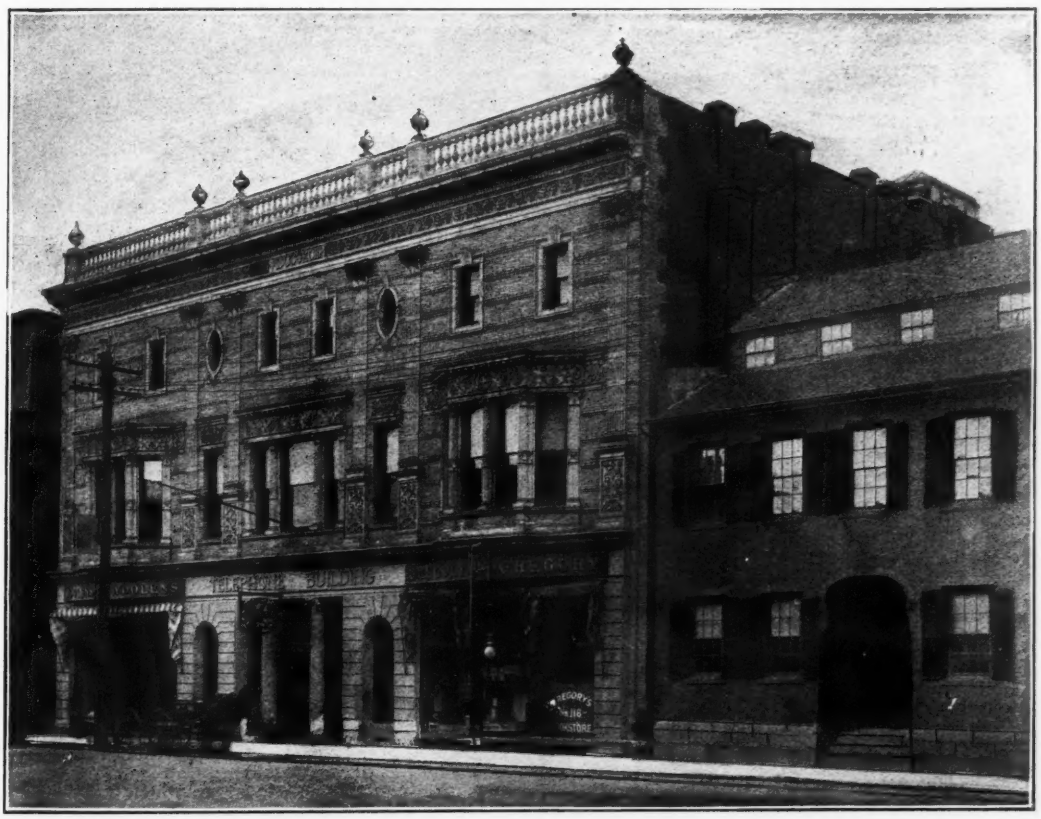
THE Providence Telephone Company was organized in 1880, with Henry Howard as its president. Its capital stock was $35,000. It has been increased from time to time, as the constantly increasing demand for telephone service required, until it is now $1,600,000. It now has about ten thousand stations.

Ex-Governor Howard retained his office as president of the company until his resignation, August 1, 1892, when he was succeeded by Henry C. Cranston.

Mr. Charles T. Howard was elected treasurer in 1881, and is the present incumbent of the office.

Mr. Albert C. White was appointed electrician of the company in 1881, and was promoted to superintendent in 1884, and to that of general manager in 1895, which office he still holds.

The following gentlemen constitute the present Board of Directors: Henry G. Russell, James H. Chace, R. G. Hazard, H. F. Barrows, H. F. Peckham, Dexter B. Potter, Samuel P. Colt, W. G. Nightingale, Thomas Sherwin, Nelson W. Aldrich, James M. Scott, Robert W. Taft and Frederick P. Fish.



TELEPHONE BUILDING, PROVIDENCE, R. I.

In 1890 the company purchased a lot and erected thereon a new fireproof building for its exclusive use. The building is located on the easterly side of Union Street, between Washington and Fulton Streets. The building is of Italian renaissance style of architecture with granite and Indiana Oolitic limestone for the first story, and buff brick and terra-cotta for the two upper stories. The first story main entrance is flanked on either side with Ionic columns of granite and lead into a spacious well-lighted lobby, which is furnished as a telephone pay station with booths for long-distance and local use, and desks and tables for the use of its patrons, where letters may be written by persons in waiting. The staircase to the second story leads to the business offices of the president, treasurer and general manager. On the third floor is located the operating room and distributing room, and retiring room for the operators.

The Providence Telephone Company has one of the best equipped exchanges in the country, and by liberal expenditure the company has placed itself in the front rank, and will continue to give the public unsurpassed service. Its territory includes all of the State of Rhode Island and exchanges at Attleboro and North Attleboro, Mass.

DEXTER B. POTTER, President
CHARLES T. HOWARD, Treasurer
A. C. WHITE, Gen'l Manager

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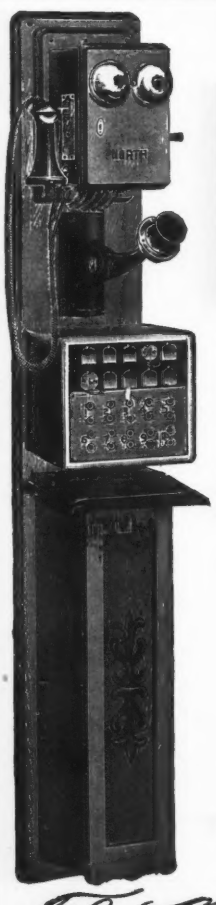
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(*Continued from page 84.*)

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Standard Underground Cable Co.
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Gen'l Incandescent Arc Light Co.
Ohio Electric Works.

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Adams-Bagnall Electric Co.
Central Electric Co.
General Electric Co.
Gen'l Incandescent Arc Light Co
Hamblin, John A.
Jandus Electric Co.
Lea Electric Mfg. Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.
Williams, Edwin I.

Lamps, Decorative.
Central Electric Co.
Edison Decorative & Miniature Lamp Department.
Gen'l Incandescent Arc Light Co.
Ohio Electric Works.

Lamps, Incandescent.
Buckeye Electric Co
Colorado Lamp Co.
General Electric Co.
Gen'l Incandescent Arc Light Co.
Goodchild & Welsh.
New York & Ohio Co.
Ohio Electric Works.
Phelps Co.
Sawyer-Man Electric Co.
Schlesinger & Mears.
Shelby Electric Co.
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General Electric Co.
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Lunkenheimer Co., The
Siegrist Lubricator Co.

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T. H. Brady.

Meters.
Fort Wayne Electric Works.

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Mica Insulator Co.
Munsell, Eugene.

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Standard Paint Co.

(*Continued on page 110.*)

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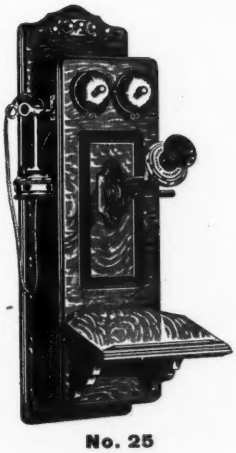

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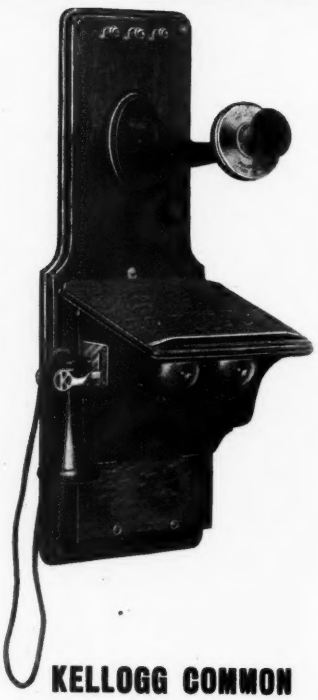

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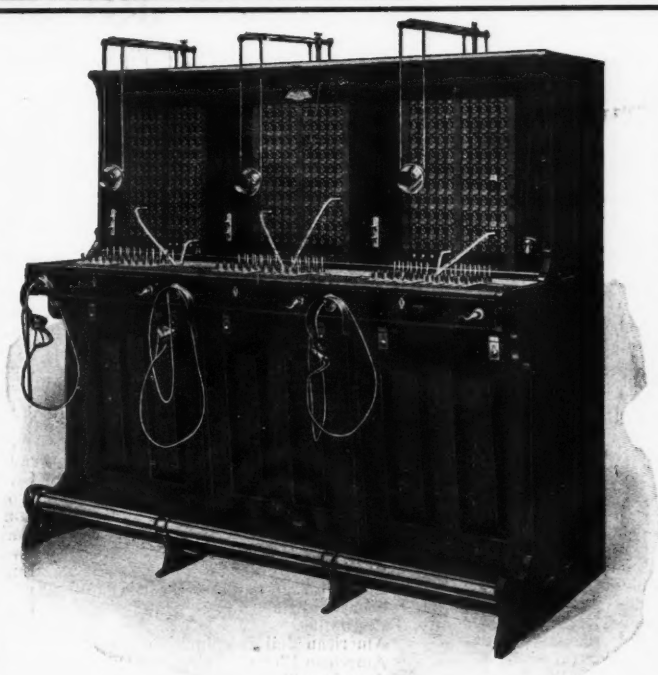
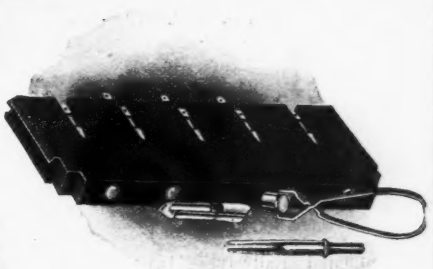
The section shown has a capacity of 300 magneto lines, and is equipped with the Kellogg combined mechanically self-restoring drop and jack. In each end-position is shown, just beneath the drops, the lamp transfers, five in number, with a capacity of ten in each position. These are operated by ten cells of Fuller battery. As an illustration of the workings of these lamp transfers, a subscriber asks the operator at the right for a number in the position on her extreme left; she immediately plugs into the transfer lamp-jack, as shown in the illustration, which lights her lamp, and the corresponding lamp in the position where the connection is desired. This being a signal for the second operator, she immediately plugs into the jack corresponding to this lamp, as shown, which being done, extinguishes both lamps. This completes the circuit between the two operators, and the second operator makes the desired connection. After the conversation has ended, the subscriber rings off, operating clearing-out drops in both positions. No "hang-ups" can occur, because if one operator only pulls down the connection, this operation illuminates the lamps in both positions, thus telling the other operator that the conversation has ended and the connection should be taken down, which being done, both lamps are extinguished.



300-LINE EXPRESS, WITH LAMP TRANSFERS

Each position is separated by a quartered-oak panel. A key is mounted on the two middle and left-hand end panels, which are so arranged that only one generator, either hand or power, can be connected in at any one time. The fourth switch, as shown on the extreme right, controls the night-bell alarm. The drops are of the tubular type, giving the maximum electrical and mechanical efficiency. The jacks and drops are rigidly connected by a metallic mounting strip, thus making adjustment permanent. The drop is cut out during conversation. Drops and jacks are mounted five per strip and fastened to a structural steel frame. High-wound, tubular type clearing-out drops, bridged across the cord circuit. Each key is so arranged, if desired, that the operator can ring out on either answering or connecting cord. Plugs and cords same as used on our large multiple boards. The plugs are reinforced by a steel-pointed tip. The board is wired on the full metallic plan. Operator's transmitter is the well-known Kellogg type, adapted for long-distance work.



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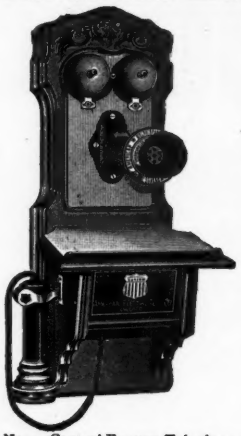

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Rosenbaum, Wm. A
Siggers, E. G.
Thompson, Edw. P.

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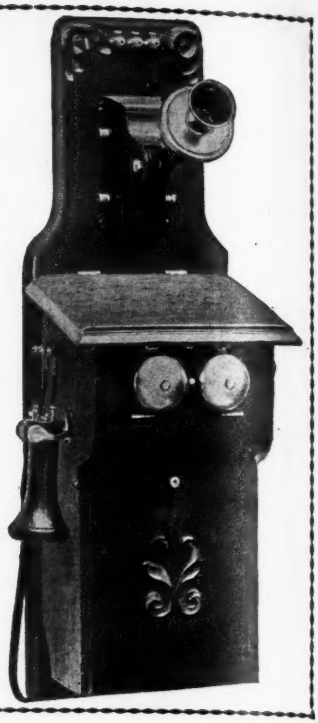

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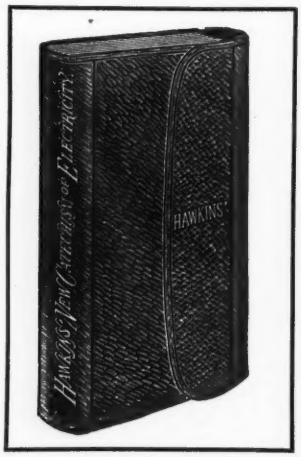

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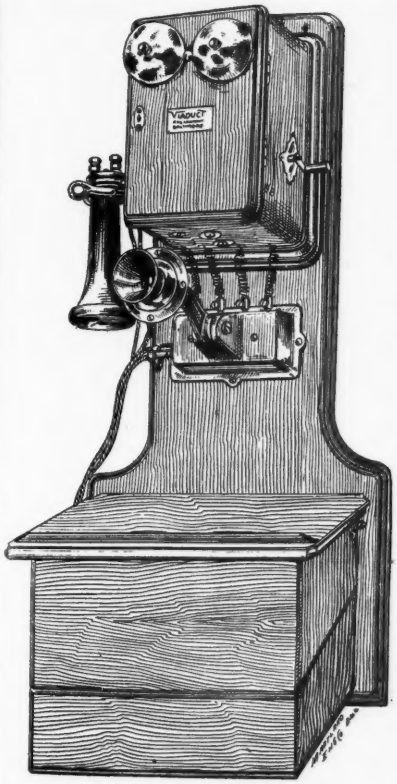

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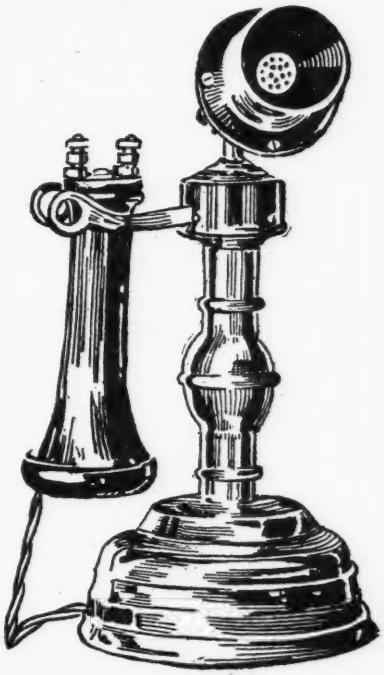

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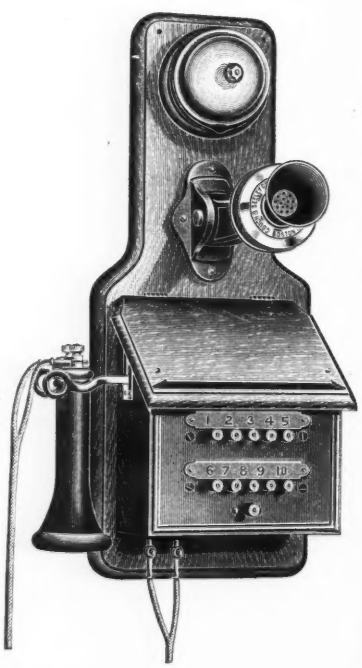

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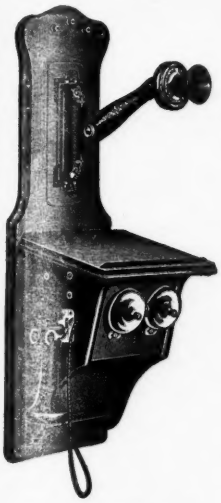

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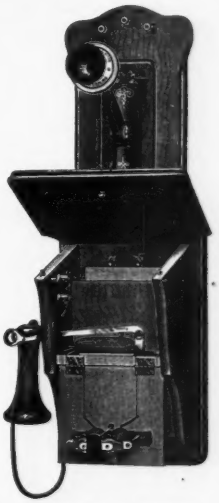

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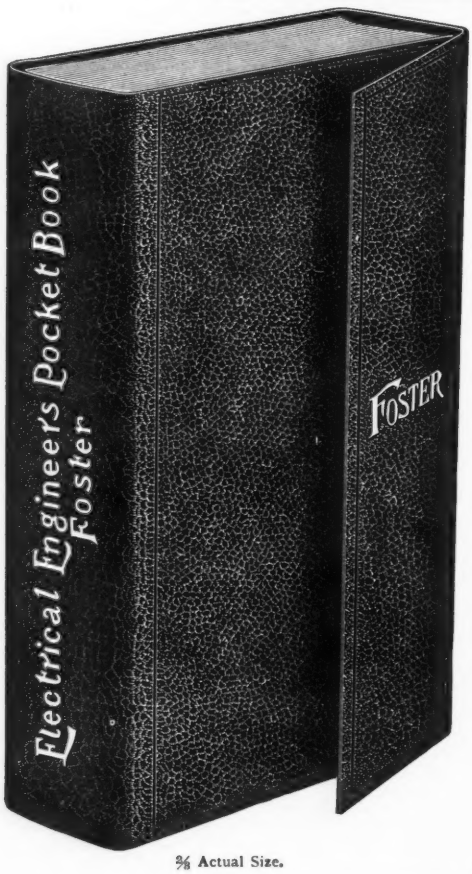

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This book is not an encyclopedia, nor is it intended for a text-book, but it is hoped that as a compendium of useful data, it may assist the practising electrician and engineer.

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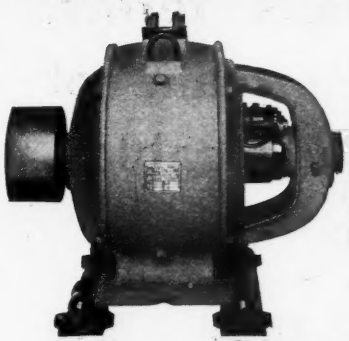

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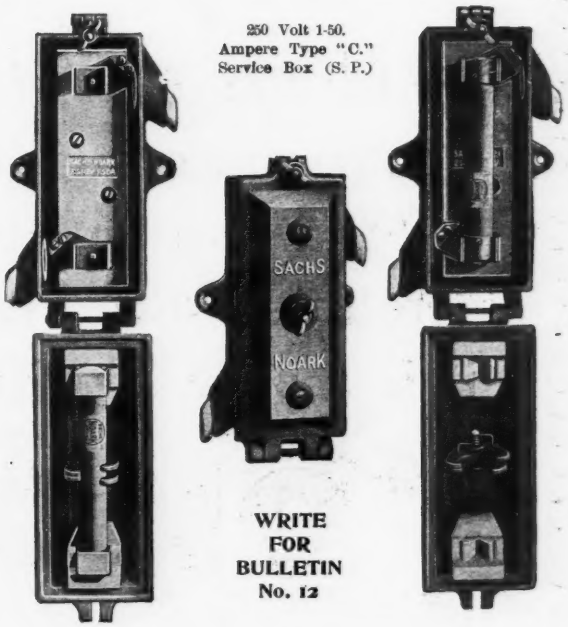

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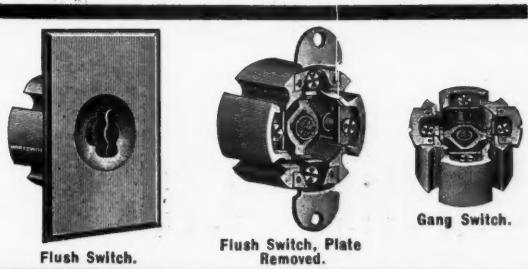

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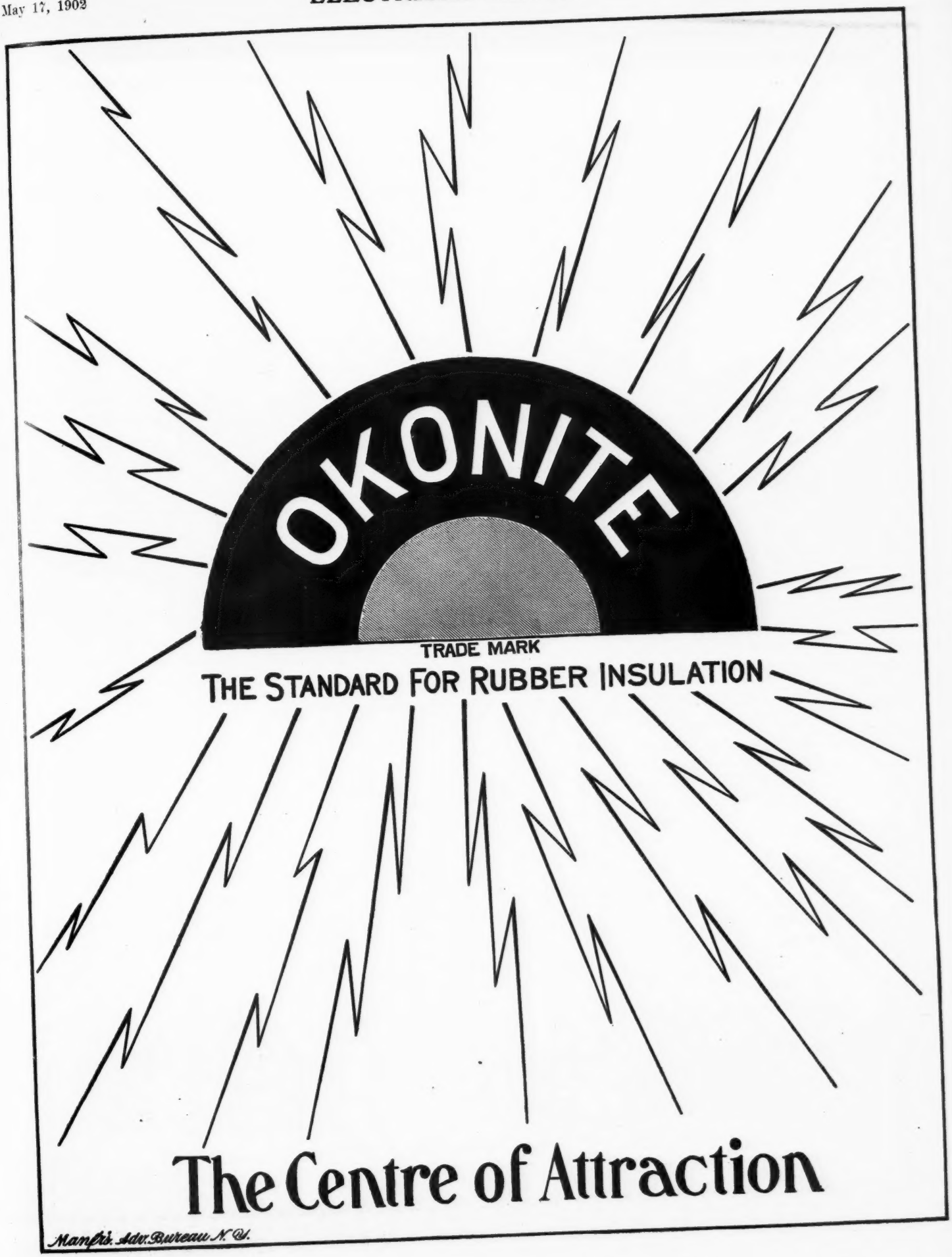
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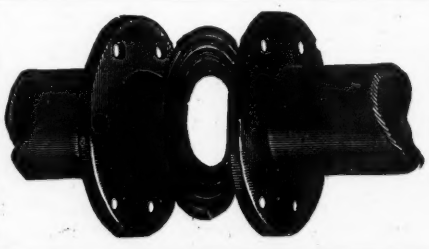

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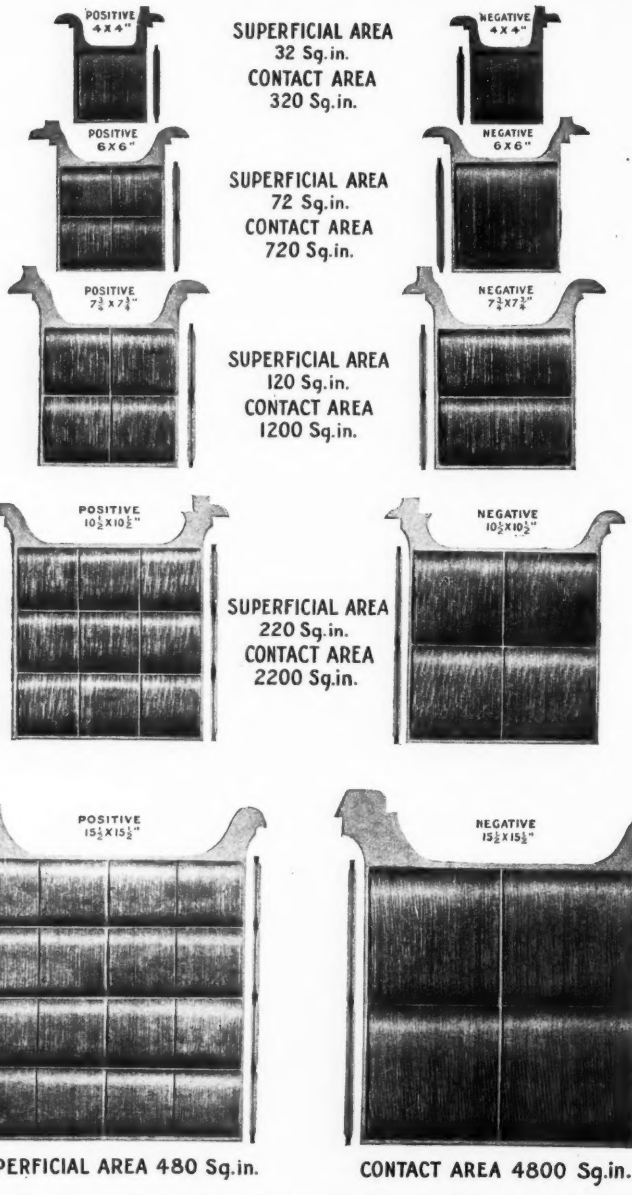

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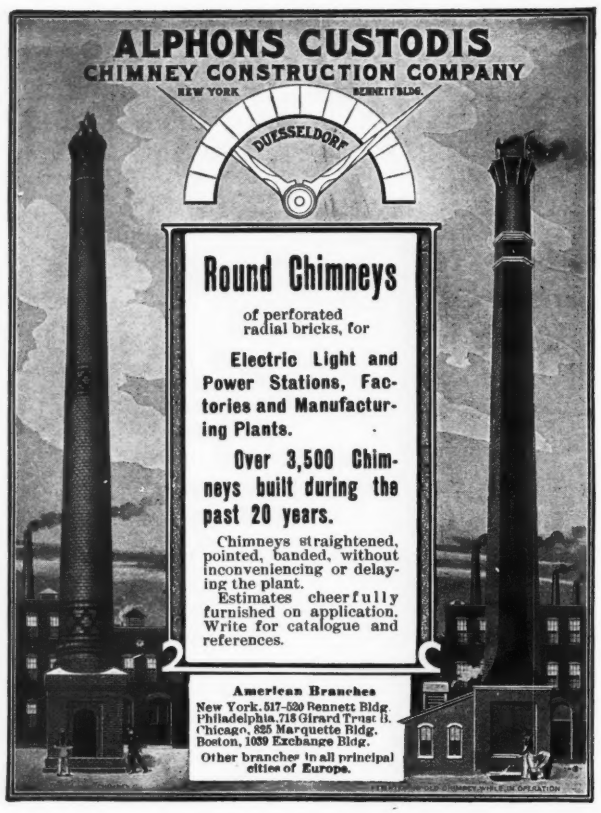
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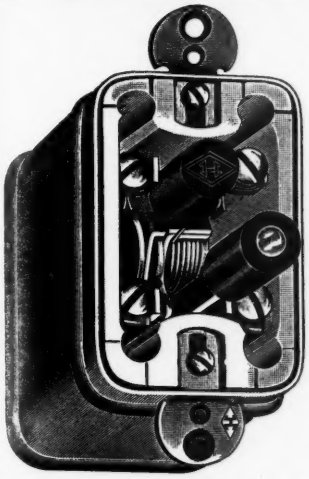

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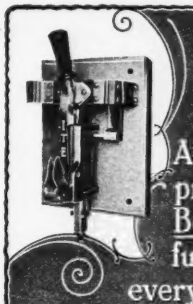

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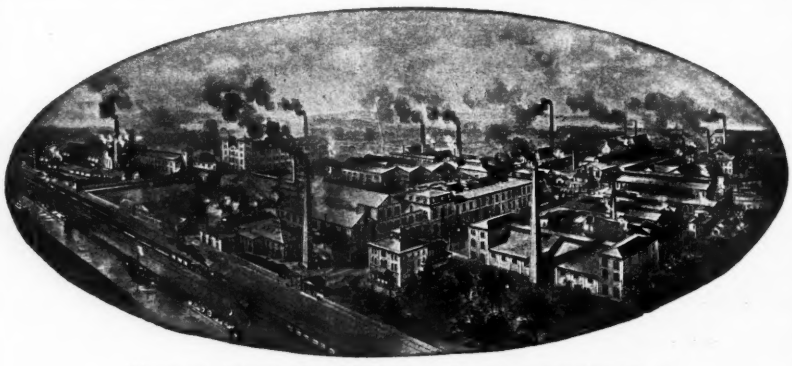


Works of John A. Roebling's Sons Company, Trenton, N. J.

For AERIAL and UNDERGROUND LINES and for all purposes

—TROLLEY WIRE—

John A. Roebling's Sons Co.

TRENTON, N. J.

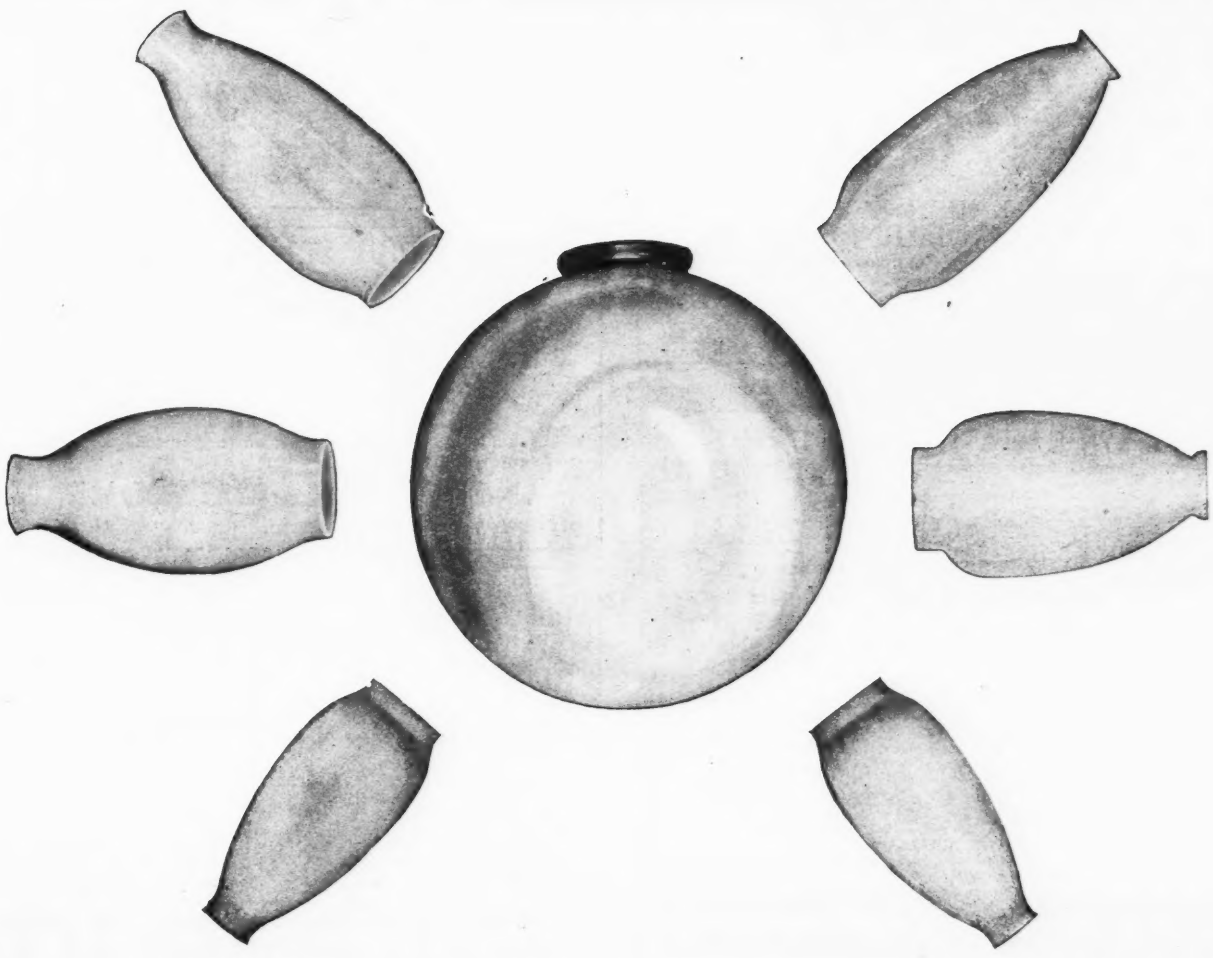
171-173 Lake Street, Chicago - - 27 Fremont Street, San Francisco

JOHN A. ROEBLING'S SONS CO. OF NEW YORK

117-119 Liberty Street, New York - - H. L. SHIPPY, Treasurer

Who makes the best inner and outer Globes for Arc Lamps?

Ask our Customers, then write us for Prices



THE PHOENIX GLASS COMPANY

Pittsburg New York Chicago

SIEGRIST SYSTEM,

AUTOMATIC LUBRICATION----PATENTED.

THE GREAT OIL AND LABOR SAVER. PAYS A BIG INTEREST ON THE INVESTMENT.
NOT AFFECTED BY HEAT OR COLD. PLENTY OF OIL UNDER ALL CONDITIONS.

OWNERS AND CONSULTING ENGINEERS ARE INSTALLING IT ALL OVER THE WORLD.

A LIST OF USERS FURNISHED BY ADDRESSING **SIEGRIST LUBRICATOR CO., ST. LOUIS, MO., U. S. A.**

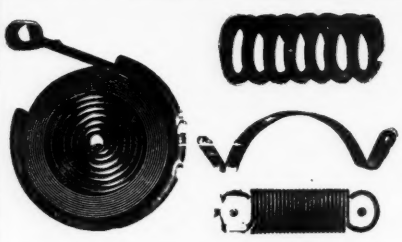
SPRINGS

(All the small springs used by electrical trade . . . . .)

THE WALLACE BARNES CO.
Bristol, Conn. Established 1857

Submit samples or specifications for quotations . . . . . .

ASK FOR CATALOGUE A A.



Cary Spring Works
240 & 242 West 29th St.
NEW YORK CITY : : : :

Manufacturers of

Wire and Springs

For Machinery Motors, Clocks, Music Boxes and all kinds of Electrical Purposes : : : : :

A WORD ABOUT SOLDERING FLUX FOR ELECTRICAL USE

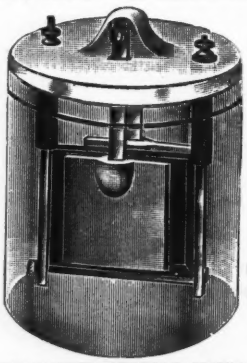
Poor flux is easily made, but to make good flux requires experience and brains. We employ an expert chemist who makes a special study of this subject, and as a resu't we believe we have reached one step nearer perfection than any of our competitors. But don't take our word for it; get the **Victor Soldering Stick** or **Victor Soldering Paste** and compare it with that which you are using.

The genuine bears our trade-mark on every package. Obtain it from your supply dealer or write us. Samples free.

ANCHOR CHEMICAL COMPANY
541 Gates Avenue, BROOKLYN, N. Y.

EDISON PRIMARY BATTERIES

Formerly known as the Edison-Lalande.



FOR GAS ENGINES, SLOT MACHINES, AUTOMOBILES, RAILROAD SIGNALS, CROSSING BELLS, SMALL MOTORS, ETC. . . .

CONSTANT CURRENT
NO LOCAL ACTION,
WILL NOT FREEZE.
LIQUID TIGHT
CELLS FOR PORTABLE WORK

Full Description in Booklet No. 17.

EDISON MANUFACTURING COMPANY.
Factory, Orange, New Jersey, U. S. A. New York Office, 83 Chambers Street.
Chicago Office, 144 Wabash Avenue.

Entirely Satisfactory

The Cumberland Telephone and Telegraph Co., Nashville, Tenn., write:—"*Replying to yours of the 14th inst. with reference to Leeds Portable Testing Set would say that we are pleased to advise you that this set is entirely satisfactory.*"

It is real economy to any Telephone Exchange to have a Leeds Set on hand for testing lines, locating faults, etc. Catalogue free on request.

JAMES G. BIDDLE
Stephen Girard Bldg., Philadelphia

STORAGE BATTERIES

For Lighting Plants, Railroad Cars and Buildings

For Automobiles and Power *The Only Battery for Practical Purposes*

WE MAINTAIN AND GUARANTEE
ALL OF OUR LINES OF BATTERIES

Estimates Furnished for any Capacity

United States Accumulator Co.
212 EAST ILLINOIS ST., CHICAGO, ILL.

THE REUTERDAHL STORAGE BATTERY

OUR
Electrochemically Formed Plate

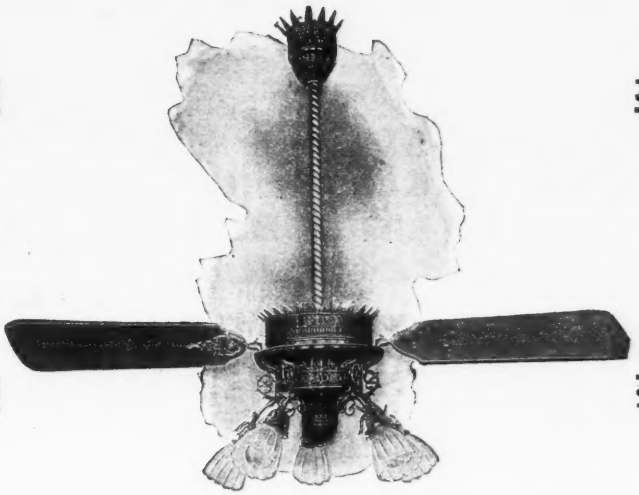
IS CONSTRUCTED IN ACCORDANCE WITH THE MOST ADVANCED IDEAS OF MODERN ELECTROCHEMISTRY

WRITE FOR BULLETIN G

REUTERDAHL ELECTRIC CO. PROVIDENCE R.I.
WESTERN OFFICE. 1504 MONADNOCK BLOCK. CHICAGO ILL.

ELECTRIC FANS

FOR EVERY REQUIREMENT



NEAT, ARTISTIC, DURABLE.

All Currents=All Voltages

Diehl D. C. Desk, Bracket, Ceiling.

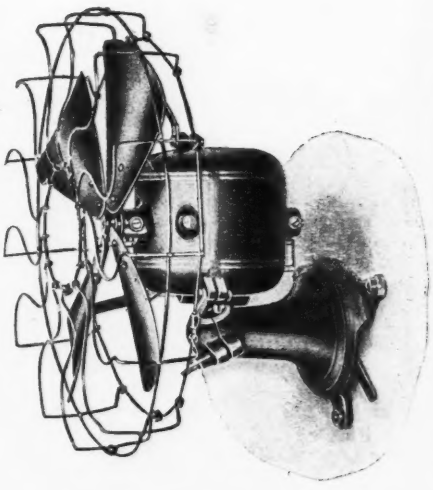
General Electric A. C. Desk and Bracket.

Westinghouse A.C. Desk.

Tuerk A. C. Ceiling.

Battery Fan Outfits.

Ventilating Fans.



SEND FOR OUR FAN CATALOGUE

Central Electric Company,

264-266-268-270 FIFTH AVENUE

CHICAGO

OKONITE IT NEVER DISAPPOINTS

OKONITE IT NEVER DISAPPOINTS

DIEHL ELECTRIC FANS

Handsomest Fan ever produced. We have 11 other cheaper designs, all good.

Are extremely popular with

ALL ELECTRIC LIGHTING COMPANIES

throughout the world

who appreciate

Efficiency and Durability

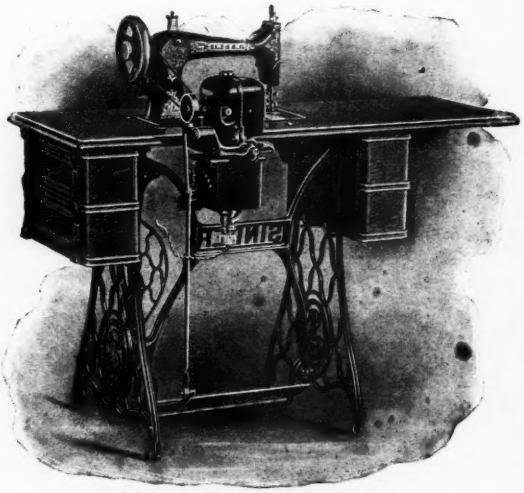
Three Sizes—Five Types—All Voltages.

OVER 100,000 FANS in operation giving **PERFECT SATISFACTION**

Exhaust Outfits of All Sizes.

Bulletin No. 60 gives full description of our Enclosed Motor attached to different makes of Exhaust Wheels and Blowers, running Horizontal or Vertical.

Bulletin No. 51 shows the different applications of our I. C. Motor to family and manufacturing sewing machines.



I. C. Motor can be Applied to Any Machine.

All of Our Representatives carry from 100 to several carloads of Fans in Stock.

Canadian General Electric Co., Toronto, Canada.
Central Electric Co., Chicago, Ill.
Cleveland Electrical & Mfg. Co., Cleveland, Ohio.
Commercial Electrical Supply Co., Cleveland, Ohio.
Doubleday-Hill Electric Co., Pittsburgh, Pa.
Electric Construction Co. of Virginia, Richmond, Va.
Electric Supply Co., Memphis, Tenn.
Electric Supply Co., Savannah, Ga.
Grand Rapids Electric Co., Grand Rapids, Mich.
Hartford Electrical Supply Co., Hartford, Conn.
H. E. Lindsey Electrical Supply Co., St. Louis, Mo.
James Clark, Jr., & Co., Louisville, Ky.
Jas. L. Belote, Norfolk, Va.
J. R. Galloway, Washington, D. C.
Michigan Electric Co., Detroit, Mich.
Newman-Spranley Co., New Orleans, La.
Post-Glover Electric Co., Cincinnati, Ohio.
Roe & Conover, Newark, N. J.
Rudolf Schmidt & Co., Rochester, N. Y.
Southern Electrical Supply Co., Macon, Ga.
Southern Electric Co., Baltimore, Md.
Specialty Mfg. Co., Indianapolis, Ind.
T. H. Smith, Denver, Col.
Union Hardware & Electrical Supply Co., Providence, R. I.
United Electric Co., Birmingham, Ala.
Waco Electrical Supply Co., Waco, Texas.
W. T. Osborn & Co., Kansas City, Mo.

SHOW ROOMS

561 Broadway, - - New York.
Central Electric Co., - Chicago.
128 Essex St., - - Boston.
1217 Filbert St., - - Philadelphia.
Newman-Sbrangley Co., Ltd., - New Orleans.

DIEHL MANUFACTURING CO.,
Main Office and Works
Elizabethport, N.J.

Have We Your Order
IF NOT, WHY?

THE COMFORT OSCILLATING ELECTRIC FAN

THREE DEFLECTING BLADES IN FRONT OF FAN BLADES CAUSING OSCILLATION.
MOTOR TURNS ON BALL BEARINGS.
SCREWS FOR CONTROLLING SPEED OF OSCILLATION.
REVERSING LEVER ATTACHED TO DEFLECTING BLADES.
ADJUSTABLE REVERSING STUDS FOR REGULATING SCOPE OF OSCILLATION.

Something Brand New

It does not simply "bore a hole in the air."
It does automatically what a "Palm Leaf Fan" in the hand will do.

Every Dealer Must Have It

Order Sample Fan Now

The ONLY Fan to Buy

Patented in the U. S. and Foreign Countries.

It has eliminated the great and growing objection to Electric Fans, *i. e.*, the disagreeable and dangerous draught common to all other Electric Fans.

The "Comfort OSCILLATING Electric Fan" because it Oscillates (turning from side to side) reaches *every corner* of a

ROOM, OFFICE, SHOP OR STORE.

***Fanning all alike,* Not chilling one and letting all others swelter.**

The Shedd Electric and Mfg. Co.

136 LIBERTY STREET, NEW YORK

THE NEW FOUR-BLADED CEILING FANS

Tuerk Alternating Current

They will run at full speed with a consumption of only from 100 to 110 watts, with a spread of 60 inches on blades and a width of 8 inches, same as used on our Two-Bladed Fan. They are supplied with our well-known spiral-grooved oiling system, and a stopping and starting switch, and a blade adjuster, permitting the angle of two blades to be changed while fan is in motion.

Furnished to run on any cycle from 40 to 140 and any voltage from 50 to 230. 40 and 50-cycle Fans are equipped with special motor, giving speed of 180 revolutions per minute and consuming only 90 watts.

Send for full information and prices before ordering elsewhere.

General and Export Agents
E. B. LATHAM & CO.
39 Vesey Street, New York

HUNTER FAN AND MOTOR CO.
FULTON, N. Y.

Western Agents
WESTERN ELECTRIC CO.
CHICAGO AND ST. LOUIS

THE CONSOLIDATED "AXLE LIGHT" SYSTEM OF

Electric Lights and Fans

FOR ALL KINDS OF RAILWAY PASSENGER CARS

☞ Adopted as the electric lighting system on Pullman Private Cars

By this system Electricity for the lighting of railway cars is generated by means of a Dynamo driven by the Axle while the car is in motion, and is supplied automatically from storage batteries when the car is stationary.

Each car carries its own electric lighting apparatus, being entirely independent of all other cars or of any charging plant.

Electric lights and fans keep a car bright and well ventilated.

The system has been demonstrated to be efficient, economical and—above all—Safe; and has come to stay.

CONSOLIDATED RAILWAY ELECTRIC LIGHTING AND EQUIPMENT COMPANY

100 BROADWAY NEW YORK

J. L. WATSON, Secretary and Treasurer
JNO. T. DICKINSON, General Agent, N.Y.
GEO. W. CARHART, General Agent,
83 West Jackson Blvd., Chicago, Ill.

H. M. Abbott
Vice-Pres't and Gen'l Manager

ADJUSTABLE FAN SUPPORTS

Will hold any make or kind of Electric Fan. ◂ Drives the air in any direction. ◂ Adjusts by the handle. ◂ No screws to slacken.

Pat. April 16, 1901. **$1.50 Each.**

Specify whether for wall or table.

SCOTT & WILLIAMS, 2079 E. Cumberland St., Philadelphia, Pa., U. S. A.

BATES ELECTRIC FANS

DIRECT CURRENT ONLY

Before making contracts write for Catalogue

HIGHEST ELECTRICAL EFFICIENCY

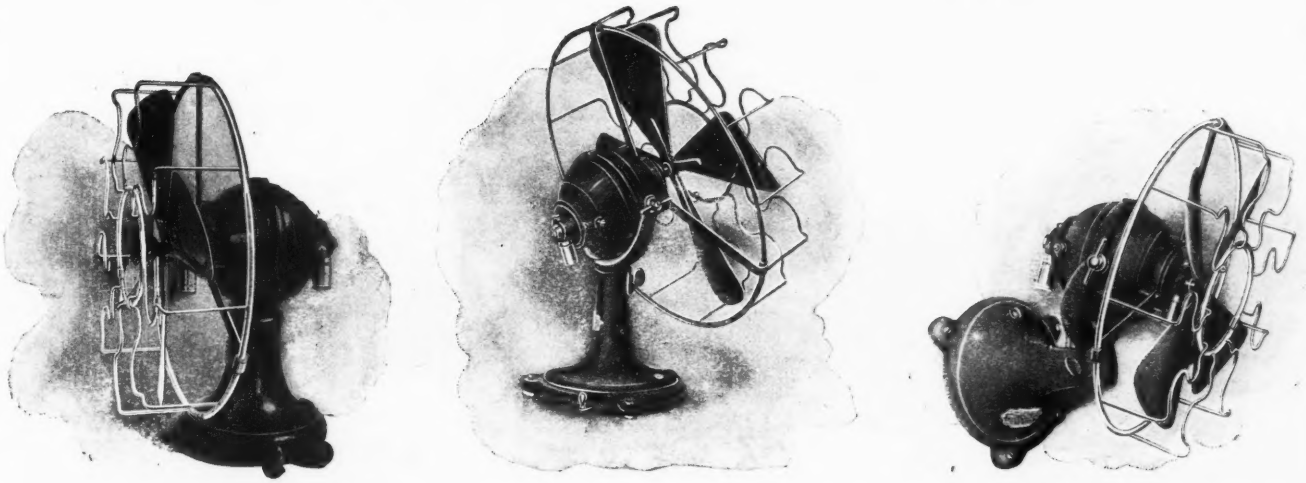
Ceiling, wall, desk, column, bracket and trunnion type

HAVE A NATIONAL REPUTATION. | SOLD THROUGHOUT THE WORLD. | GIVE UNIVERSAL SATISFACTION.

D. L. BATES & BRO.
DAYTON, OHIO, U. S. A.

LUNDELL FANS

Are Copied but Never Equaled



SUPERIOR DESIGN AND CONSTRUCTION

UNIVERSAL FAVORITES

Lundell Fans have always given the most satisfaction to dealers and users. The various types and sizes are adapted to meet all requirements of the trade. They have the highest efficiency, are the most durable in service, and the most graceful in appearance. They run quietly and require the least attention. They have a strong torque, self-aligning and self-oiling bearings, and a regulating switch giving variations of speed best suited to the location.

Send for Catalogue No. 3046.

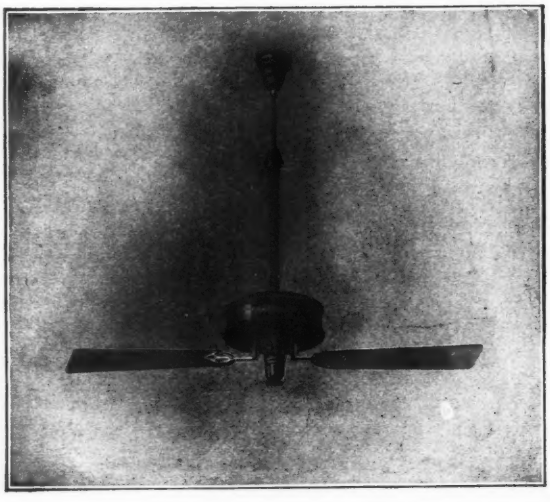
Sprague Electric Company

GENERAL OFFICES: 527-531 WEST 34th ST., NEW YORK

BRANCH OFFICES:

CHICAGO: Fisher Bldg. BOSTON: 176 Federal St. ST. LOUIS: Security Bldg. BALTIMORE: Maryland Trust Bldg.

WESTERN ELECTRICAL SUPPLY CO.



1902 MODEL

EMERSON ALTERNATING CURRENT

DESK and CEILING

FANS

ALL TYPES AND SIZES FOR ANY VOLTAGE OR ALTERNATION

Guaranteed free from all electrical and mechanical defects. Fitted with Parker noiseless blades. The only perfect Alternating Current Fan Motor on the market. Fitted with half-inch hardened steel shafts.

HANDSOME - STRONG - DURABLE

WESTERN ELECTRICAL SUPPLY CO.

ST. LOUIS, U. S. A.

WRITE TO-DAY FOR CATALOGS, PRICES, Etc.

ON the next two pages following this is shown a cut of our factory as it has been for a year and a half since the last addition was built. The PHENOMENAL growth of our business has caused us to build every year. Each time we build we make some allowance for increase, but never enough. We are now building three large brick buildings, which we expect to occupy inside of thirty days. Our prosperity has been due entirely to Peerless Incandescent Lamps, Fan Motors and Transformers. Don't use them unless you wish to grow.

On the next seven pages will be found testimonial letters from some of the largest and most responsible electrical supply dealers and contractors in the country. They all speak well of the PEERLESS, and all of them have handled our products for years. Territorial agencies for PEERLESS Incandescent Lamps, Transformers and Fan Motors are valuable because we are large advertisers, and our customers get the direct benefits derived from it in all cases. All our jobbers are fully protected.

The following pages, together with the eleven pages published in the April edition of "The American Electrician," ought to be convincing to anyone that PEERLESS products are well regarded and this Company is well up towards the front. Everything that we produce is guaranteed. Quality considered, we meet our competitors' prices always. We protect our agents—we want the trade to know we are alive. If you really want to enjoy life use PEERLESS Incandescent Lamps, Fan Motors and Transformers.

The Warren Electric & Specialty Co.

WARREN, OHIO

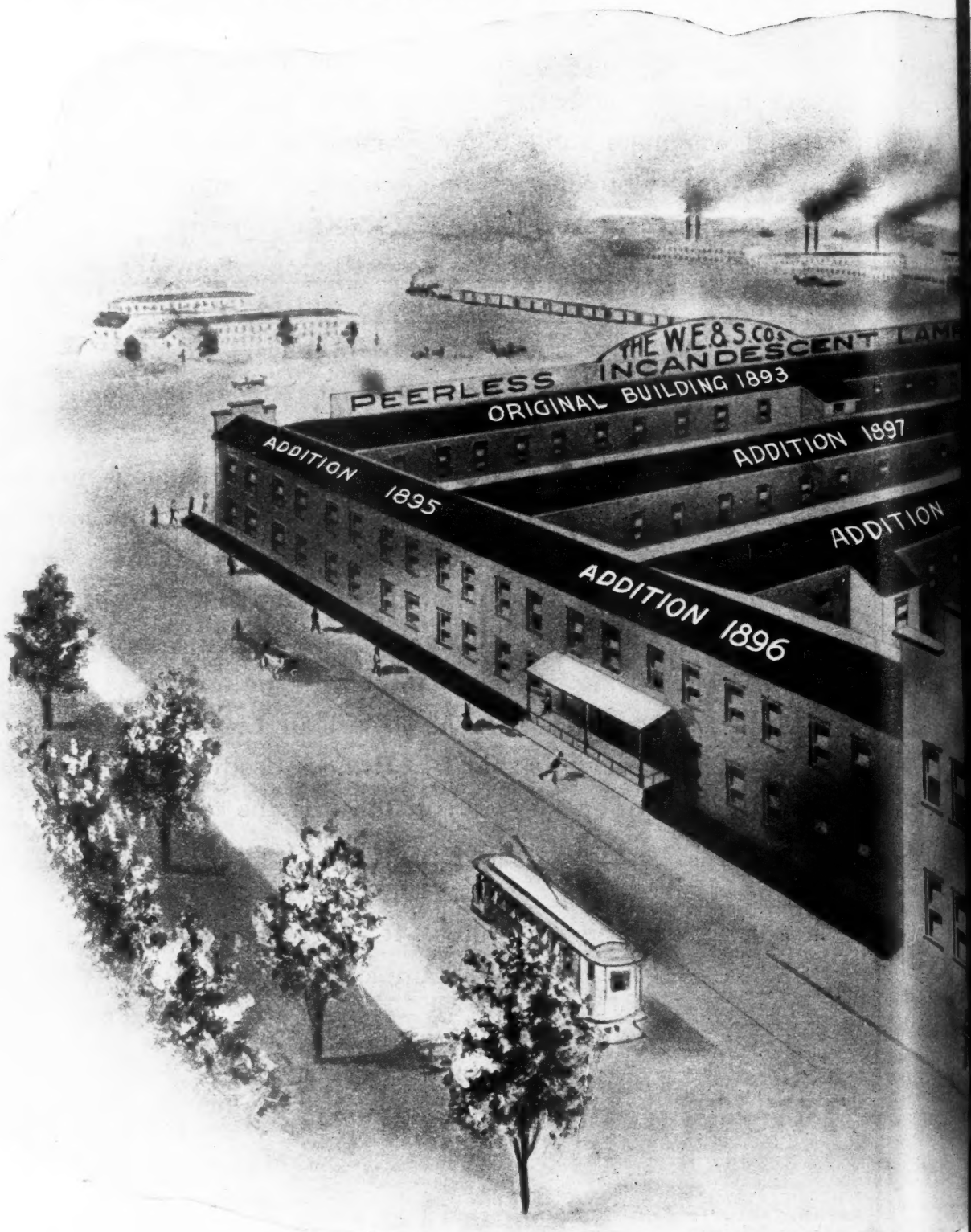
Manufacturers of **Peerless** { Incandescent Lamps / Desk and Ceiling Fan Motors / Transformers

1.

FACTORY BUILDINGS OF

THE WARREN ELECTRIC & SPECIALTY CO.

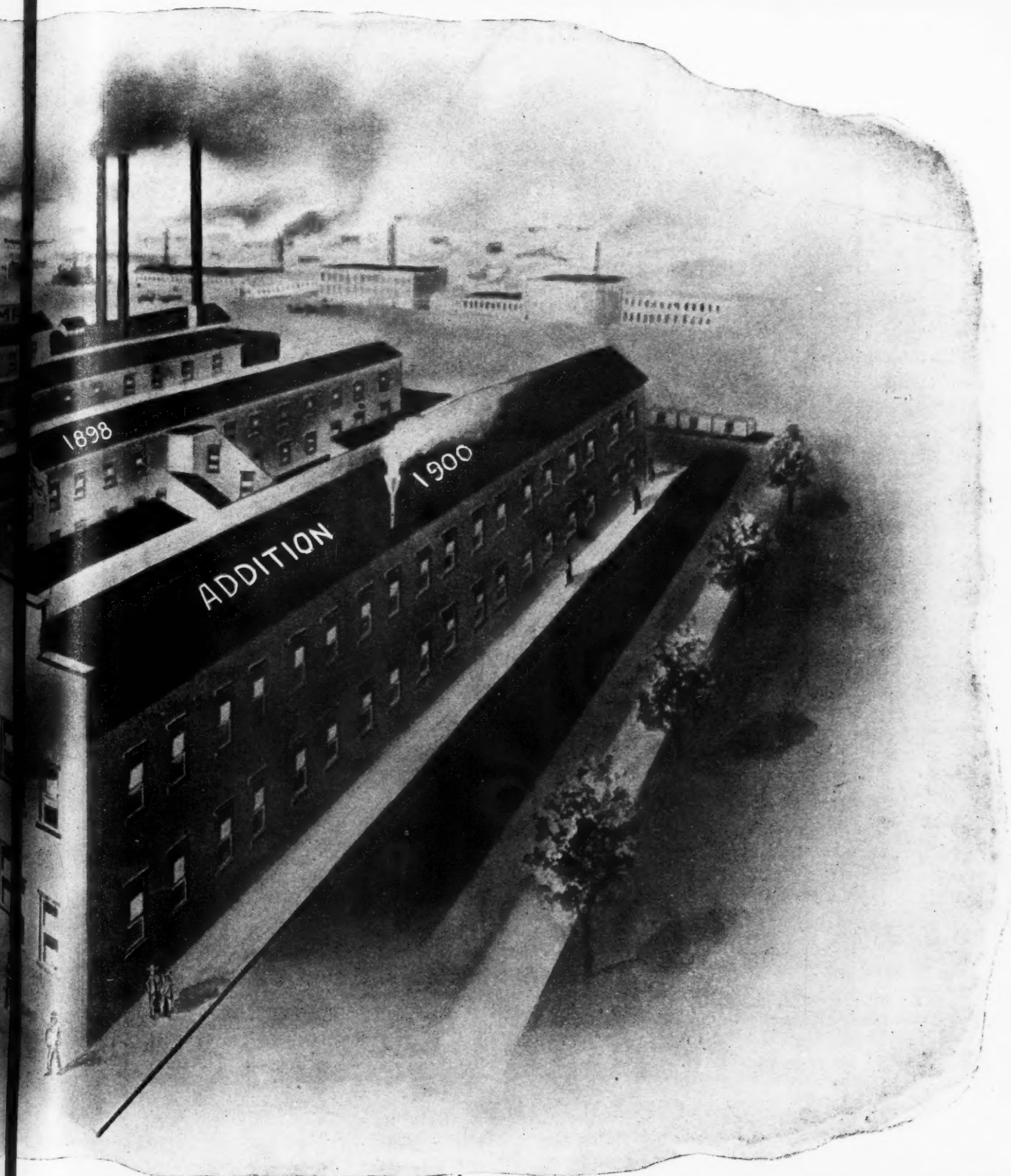
WARREN, OHIO



2.

This cut shows the size of the original plant and the additions which have been made from time to time, but does not

Manufacturers of **PEERLESS** Incandescent Lamps
Desk and Ceiling Fan Motors
Transformers



show three large brick buildings located at the right which are being built and which are now nearing completion

3.

Sole Agents.
Eddy Electric Mfg Co. Warren Electric Mfg Co. Jno. A. Roebling's Sons Co. Indiana Rub. & Ins. Wire Co.
The Adams-Bagnall Electric Co. Ohio Brass Co. Sells-Eddy Mica Co.

Western Electrical Supply Co.
Electrical Supplies,
7th St. and Clark Ave.
St. Louis, April 17th, 1902.

Warren Electric & Speciality Co

Warrem, Ohio.

Gentlemen:--

In affords us much pleasure to advise you that our experience with your Peerless Incandescent Lamps and Fan Motors, extending over a period of several years, has been eminently satisfactory.

We have sold a very large number of your Peerless Desk and Ceiling Fans in almost every section of this Country, and they have proven themselves to be the best constructed, strongest and most efficient fans on the market, and wherever we have placed them they have apparently given our customers entire satisfaction.

We regard your Incandscent Lamps to be of the very highest grade. We find them not only uniform in quality, but where we have had them in competitive test they have shown themselves to be everything claimed for them in the way of life, sustained candle power, current consumption, etc.,

Trusting that you may continue to enjoy the prosperity to which your high grade products entitle you to, believe us,

Very truly yours,

WESTER ELECTRICAL SUPPLY CO.

W. K. Gilman
President.

ADDRESS REPLY PLAINLY TO WESTERN ELECTRICAL SUPPLY CO.

4.

The Warren Electric & Specialty Co.
WARREN, OHIO
Manufacturers of Peerless { Incandescent Lamps / Desk and Ceiling Fan Motors / Transformers

C. F. HOWLAND, PRES. A. HOWLAND, VICE-PRES. G. M. STUART, TREAS. & GEN. MGR.

W. U. TEL. CODE.
CABLE ADDRESS
"STUARTLAND"

TELEPHONE BRANCH EXCHANGE 4144.
CONNECTING ALL DEPARTMENTS.

Stuart-Howland Company.
Electrical-Supplies and Specialties,
279-287 Devonshire Street.

Branch Office,
26 Portlandt St., New York.

Boston, April 2, 1902.

The Warren Electric & Specialty Co.,

Warren, Ohio.

Gentlemen:-

We are in receipt of yours of March 31st. and note you are inquisitive to know if we have any fault to find with your fan motors.

In reply would say, we have represented your lamps, fan motors and transformers since starting in business two years ago, and the fact that you have had practically no complaints from us should indicate to you that we are not receiving many from our customers, and are therefore satisfied.

Regarding fan motors, about which you inquire specifically, we are pleased to say that we do not think we have received one complaint, and are quite sure we have not been called upon to take back or repair one PEERLESS fan except a few 500 volt ceiling of a type which you have long since discarded. Considering that we have sold over 1150 of these fans in the two years, we think this a remarkable record.

We trust your product in the coming season will show the same care in manufacture as heretofore.

YOURS TRULY,

STUART-HOWLAND COMPANY,

By G M Stuart

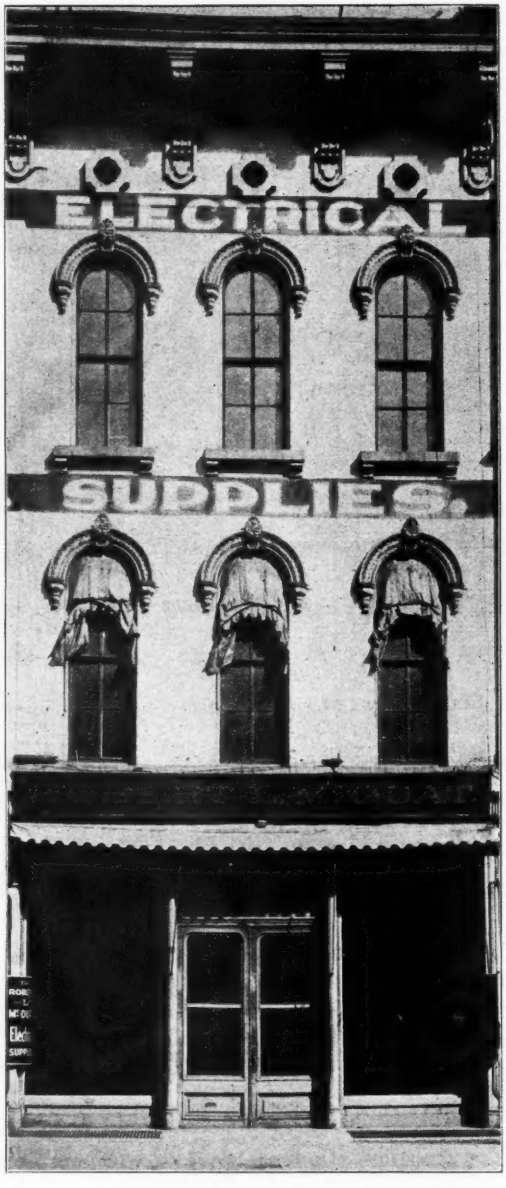
Gen.Mgr.

5.

The Warren Electric & Specialty Co.
WARREN, OHIO

Manufacturers of **Peerless** { Incandescent Lamps
Desk and Ceiling Fan Motors
Transformers

ROBERT L. McOUAT



FRED G. BALZ
General Manager

6.

ROBERT L. McOUAT
SUCCESSOR TO VARNEY & McOUAT
ELECTRICAL SUPPLIES
125 SOUTH MERIDIAN STREET INDIANAPOLIS, INDIANA

WARREN ELECTRIC & SPECIALTY CO.
WARREN, OHIO MARCH 15, 1902

Gentlemen:—

After handling Peerless Fans for several seasons we feel called upon to advise you of our high regard for them, as we believe that they are superior to any fan on the market.

Our opinion is based on the fact that complaints and repairs have been of such small account, that we might honestly state that your fans have given us no trouble.

Very truly yours,

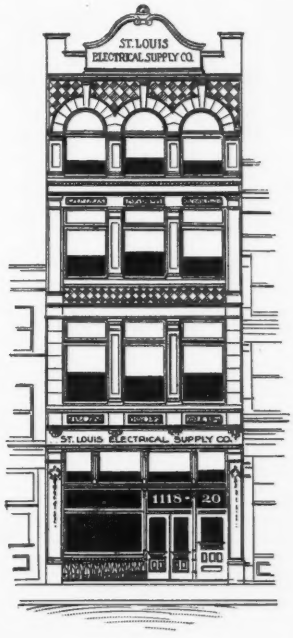
R. L. M.—O. ROBERT L. McOUAT.

The Warren Electric & Specialty Co.

Manufacturers of

Peerless Incandescent Lamps
Fan Motors
Transformers

Warren, Ohio
U. S. A.



JACOB WEINHEIMER, Pres. ESTABLISHED 1883 A. S. DOXSEE, Sec'y

ST. LOUIS ELECTRICAL SUPPLY CO.

JOBBERS

ELECTRICAL MERCHANDISE

1118 PINE STREET

7.

WARREN ELECTRIC & SPECIALTY CO. ST. LOUIS, MO., March 17, 1902.

WARREN, OHIO.

Gentlemen:—Replying to your kind inquiry of March 6th regarding your Peerless Transformers, for which we have been Southwestern and Western agents for several years, we can candidly say that we have not, or are we at present handling anything in the electrical line which has given such universal satisfaction as the Peerless Transformers, and wherever we have made sales of them, no matter whether it was a single one or a dozen, we have in every instance held the trade of these parties ever since; and we have many letters from customers which are highly complimentary to the Peerless Transformer, and if you desire, we will be very glad to favor you with copies of them.

Yours very truly,

ST. LOUIS ELEC. SUPPLY CO.

A. S. DOXSEE, Secretary.

The Warren Electric & Specialty Co.

Manufacturers of

Peerless Incandescent Lamps
Fan Motors
Transformers

Warren, Ohio
U. S. A.

THE STANDARD ELECTRIC COMPANY.
CINCINNATI

April 23rd, 1902.

The Warren Electric & Specialty Co.,
Warren,
Ohio.

Gentlemen:-

We take great pleasure in certifying to the excellent quality, and general make up of the Peerless Lamps and Transformers We have handled your goods for several years and to date have not had a complaint on account of defective material.

Our business in this direction has steadily increased and we feel that this is an indication that your line is giving satisfaction.

Yours very sincerely,

THE STANDARD ELECTRIC COMPANY.

8.

The Warren Electric & Specialty Co.

Manufacturers of
Peerless Incandescent Lamps
Fan Motors
Transformers

Warren, Ohio
U. S. A.

Telephone Connection.

Vallee Bros. Electrical Company

Manufacturers of and Dealers in

Electrical Supplies.

625 Arch Street,

Philadelphia.

Garrett A. Vallee, President.
George W. Vallee, Vice-Pres.
Frank D. Sweeten, Treasurer.
W. H. Grove, Secretary.
T. L. Townsend Genl. Mangr.

Electric Light,
Railway & Telephone Supplies.
Electric House-goods of
every description.

ANNOUNCEMENT.

TO THE TRADE.

We are exclusive agents in this territory for the "Peerless" fans. "Peerless" fans have been so successful during the several years that we have sold them, that little is left to be desired, but there have been some slight improvements made in the 1902 type that will further improve its appearance and quality, which will make it the best fan for you to handle.

In addition to the celebrated "Peerless" fans manufactured by the Warren Electric & Specialty Co., we desire to call your attention to the "Peerless" transformers which we handle. These transformers are recognized as the best on the market, and have met with universal favor among the most critical experts, and we trust that if you are in the market at any time for transformers, you will give the "Peerless" a trial, as we feel certain same will receive your approval upon its merits.

Trusting to receive an immediate reply, and thanking you in advance for any favors extended, we are,

Yours very truly,

VALLEE BROS. ELECTRICAL COMPANY,

T. L. Townsend

Gen'l Mgr.

9.

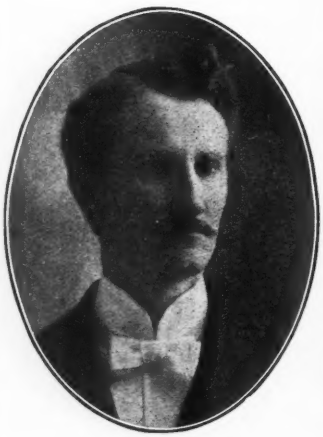
The Warren Electric & Specialty Co.

Manufacturers of

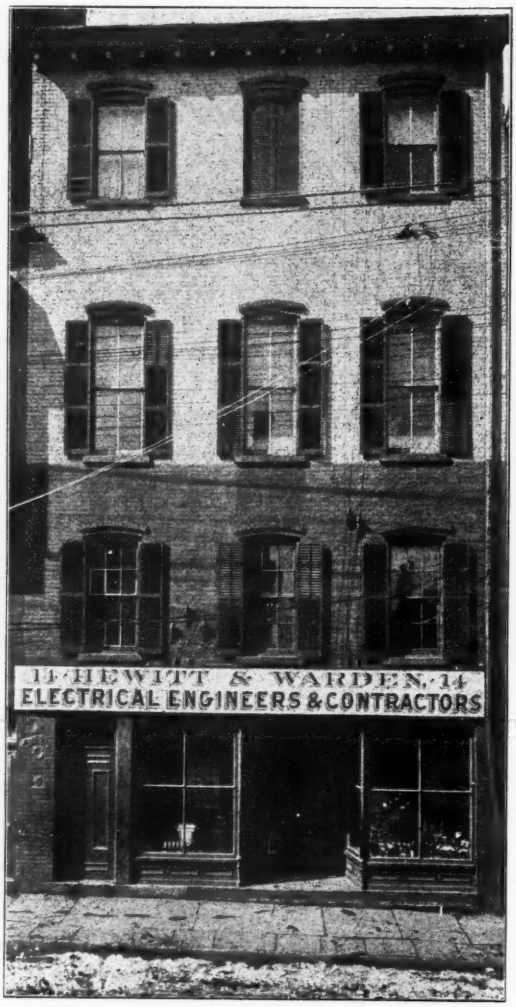
Peerless Incandescent Lamps
Fan Motors
Transformers

Warren, Ohio

U. S. A.



H. A. WARDEN



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GENERAL WIRING AND MARINE EQUIPMENTS

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WARREN, OHIO.

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Manufacturers of

Peerless Incandescent Lamps
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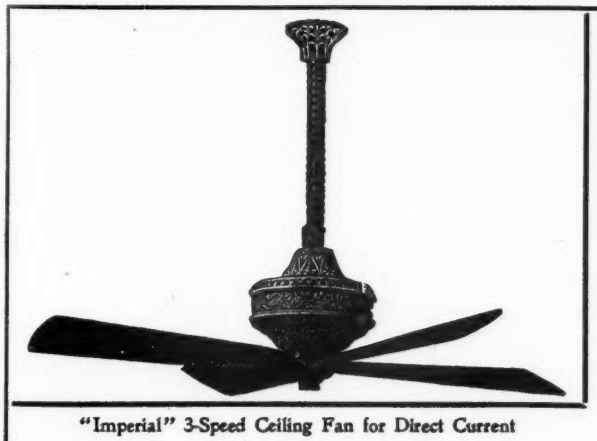

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FOR DIRECT CURRENT ONLY
Ceiling, Desk, Wall, Column
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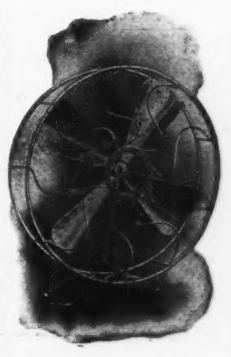
OUR FANS HAVE A NATIONAL REPUTATION, ARE SOLD THROUGHOUT THE WORLD, GIVING UNIVERSAL SATISFACTION



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in anything that will add to his success. All of them recognize the value of the show window as an advertising medium, and are interested in whatever will increase its efficiency.

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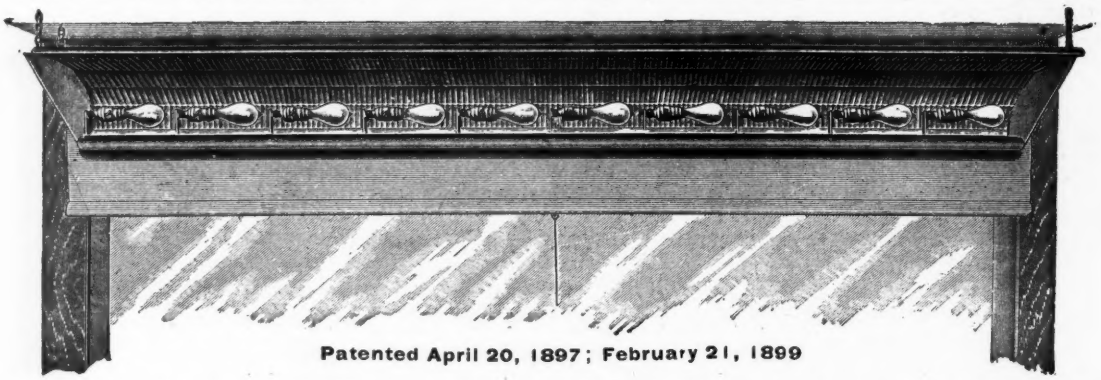

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Send for particulars on up-to-date store lighting, including our specialties in show-case lighting, and our unequaled sectional glass cluster reflectors for interior lighting. Effective, economical, durable.

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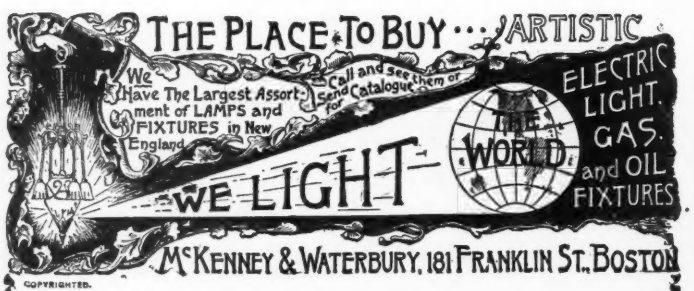
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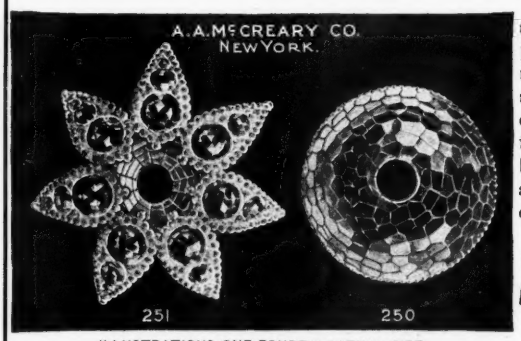

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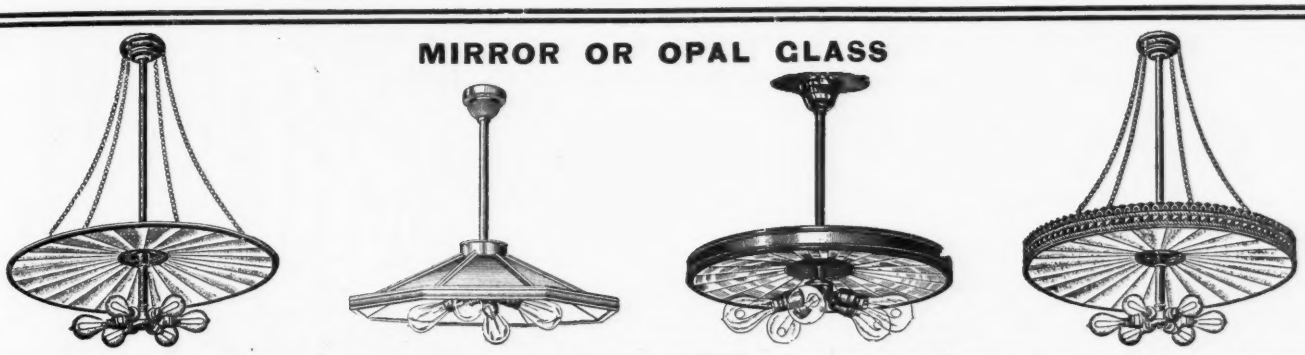
MIRROR OR OPAL GLASS



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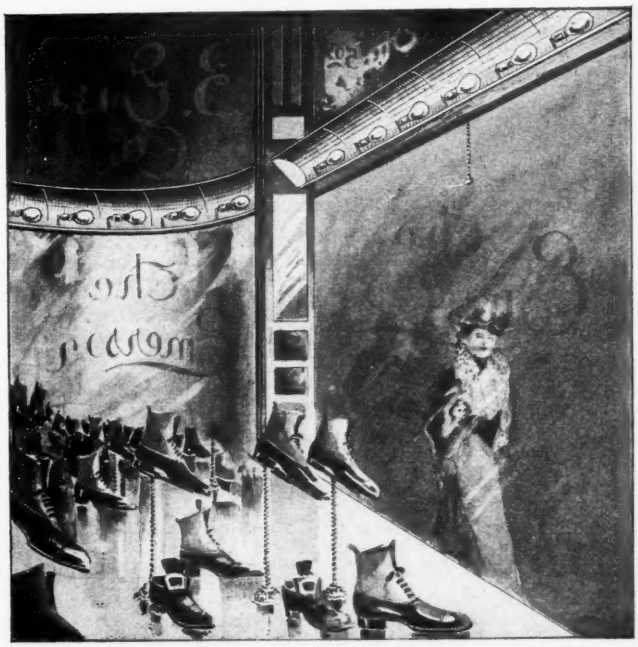

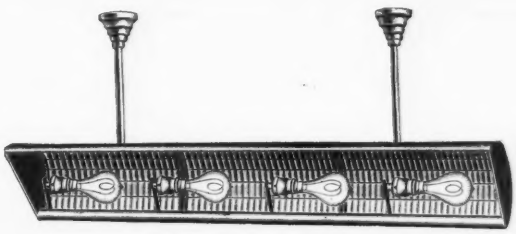

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Note the curved window.

We can make any shapes, any sizes.

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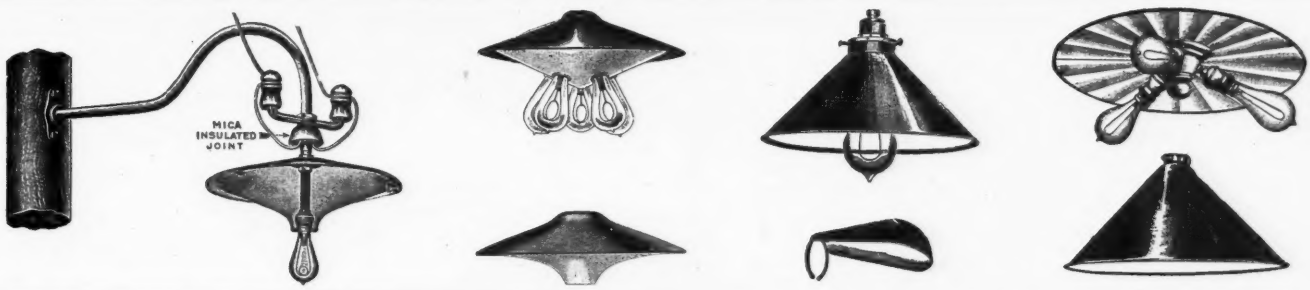

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are the kind you want for small boards. Indications are dead beat, scales are equally divided, ammeters have separate shunts and cases are of polished spun brass. Send for prices.

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Electric Wire Conduits, Couplings, Elbows, Etc. Enameled Inside and Outside

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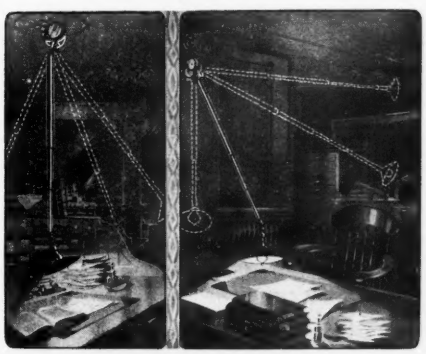

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APPROVED BY FIRE UNDERWRITERS

Finished in Nickel, Oxydized Brass and Copper. Made in three sizes, 5 ft., 8 ft., 10 ft.

Prices, $8.00, $8.50, $9.00

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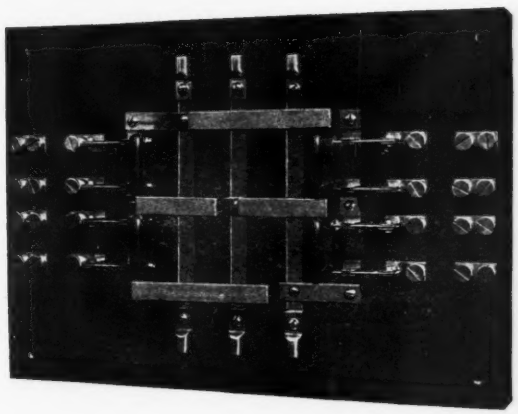
CABINETS, LININGS, ETC.



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If not satisfactory, return at our expense.

Our lamps are not refilled or made over. Where we have replaced higher priced lamps, we have had duplicate orders.

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Made on order. We have excellent facilities for producing anything you want in Porcelain in large or small quantities.

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Wherever You Stick the Lamp IT LIGHTS!

Two Points Concerning the

ELBLIGHT SYSTEM

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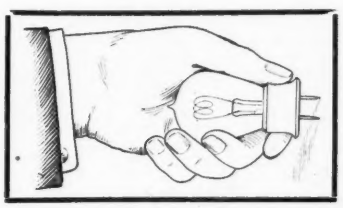
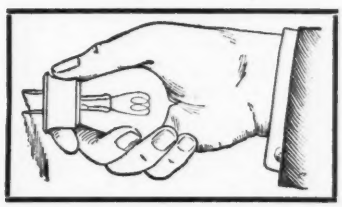


Electric Lighting Boards



which show their superior convenience:

1. **Simplicity.** ANYONE can make ANY DESIGN or ANY COMBINATION OF LETTERS, and then outline the same by simply sticking the bulbs in the board. The pictures show you how.
2. **Availability.** With the ELBLIGHT CABLES, any scheme of festooning or decoration, for either the inside or the outside of buildings, can be carried out. ELBLIGHT LAMPS can be inserted with ease at any point in the cable. The pictures show you how.

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Wherever You Stick the Lamp IT LIGHTS!

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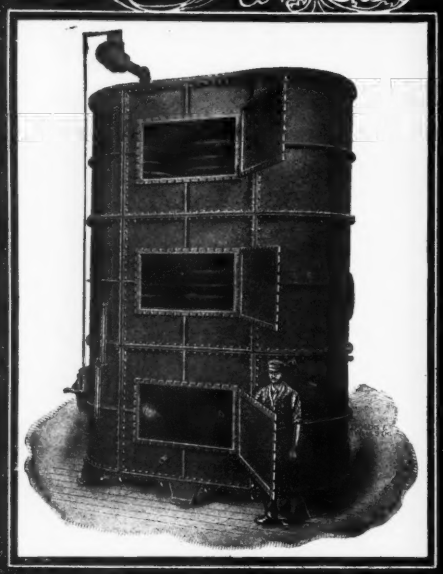

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At the same time the water is freed from scale-producing elements, keeping the boilers free from scale and adding to their life.

We also make Steam, Power and Electric Pumping Machinery, Jet and Surface Condensers, Air Compressors, Victor Turbines, Oil Mill Machinery and Filter Presses.

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For Heads of 3 Feet to 2000 Feet. Especially adapted to all kinds of

ELECTRIC POWER AND LIGHTING PLANTS

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Test of a 45 in. Samson. Jan. 25, 97.

Gate Open	Head	Rev. Pr. Min.	Cu. Ft. Pr. Sec.	Horse Power	Per Cent
Full	15.90	144.00	173.69	240.97	89.08
¾	15.04	138.12	155.08	223.61	84.53
½	15.11	127.67	138.24	191.06	88.68
¼	15.88	181.50	112.65	162.80	80.28
⅛	16.47	126.97	90.04	127.73	75.95

Test of a 35 in. Samson. Feb. 1, '97

Gate Open	Head	Rev. Pr. Min.	Cu. Ft. Pr. Sec.	Horse Power	Per Cent
Full	15.29	194.25	102.02	143.44	81.06
¾	16.56	187.75	92 15	146.73	84.78
½	17.33	178.50	83.95	138.40	83 88
¼	17.84	176.40	66.82	109.04	80.09
⅛	17.68	168.50	57.69	88.14	76.19

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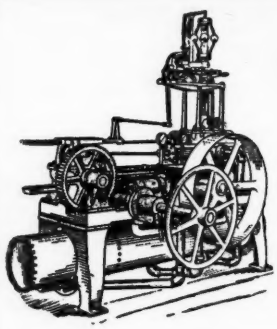

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THE LOMBARD GOVERNOR CO.
36 Whittier St. (Roxbury)
BOSTON, MASS.

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0 to 15	.2	15.50	Kamila
0 to 25	.5	15.50	Kamsin
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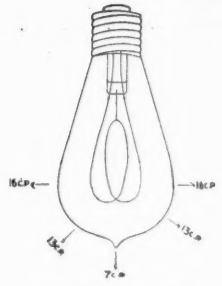

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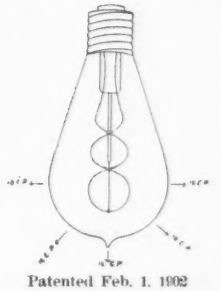

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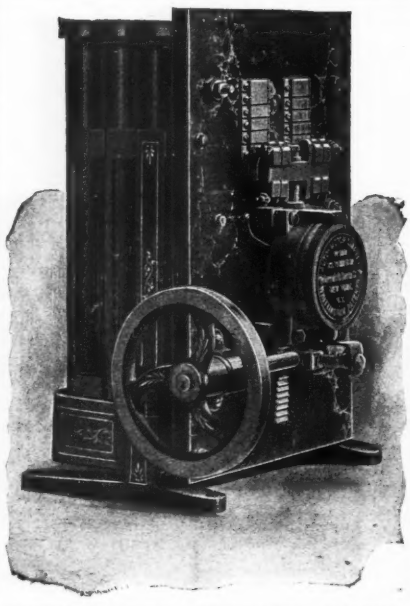

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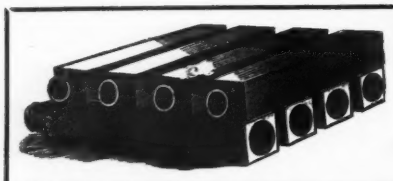

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List of Electrical Patents Issued Last Week

[Specially reported for this journal by E. S. Duvall, solicitor of patents, Loan and Trust Building, Washington, D. C. Copies of any patent may be secured for 10 cents each.]

ISSUED MAY 6, 1902.

699,140 Electrical annunciator; C. C. Blake, Brookline, Mass.

699,146 Electric combustion furnace; W. M. Carr, East St. Louis, Ill.

699,158 Wireless telegraph system; C. D. Ehret, Washington, D. C.

699,162 Telephone circuit system; E. F. Frost, Washington, D. C.

699,177 Electric call system; F. E. Huggins, Zeandale, Kan.

699,181 Junction or fuse box; M. H. Johnson, Utica, N. Y.

699,187 Means for connecting dynamos with trucks of railway cars; P. Kennedy, Brooklyn, N. Y.

699,193 Device for cleaning and rubbing collectors of electric motors and dynamo machines; W. Kuppers, Berlin, Germany.

699,196 Electric arc lamp; A. Lees, New Bedford, Mass.

699,202 Electric gas lighters; A. J. Marschall, Little Falls, N. Y.

699,205 Electric tap socket; E. B. Meyrowitz, New York, N. Y.

699,208 Vacuum tube sign; D. M. Moore, Newark, N. J.

699,215 Electrical outlet box; E. W. Muller, Brooklyn, N. Y.

699,218 Electric switch operating device; A. J. McCullough, Meadville, Pa.

(Continued on page 76.)

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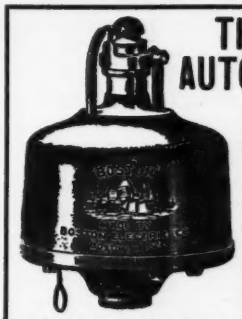

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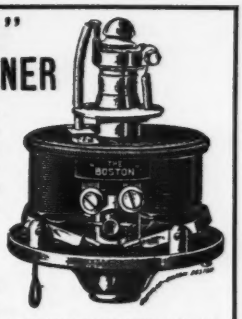

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PATENTS.

(Continued from page 75.)

699,225 Electric arc lamp; J. S. Nowotny, Madisonville, Ohio.

699,275 Automatic annunciator; J. A. Wotton, Atlanta, Ga.

699,333 Vessel for the reception of high-pressure gases; A. Ludwig, Bernburg, Germany.

699,353 Apparatus for the manufacture of carburetted hydrogen gas; E. Van Steenburg, New York, N. Y.

699,381 Outlet box for electric wires and conduits; J. M. G. Pullman, Pittsburg, Pa.

699,388 Dynamo; S. Hutchines, Manchester, England.

699,412 Device for operating electric lights in railway carriages from the guard's van; E. J. Preston, Beckenham, England.

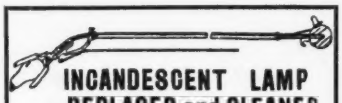
699,413 Storage battery; J. Redding, Boston, Mass.

699,415 Electrolytic apparatus; C. J. Reed, Philadelphia, Pa.

699,455 Combined hose and electric signaling device; H. T. Cronk, New York, N. Y.

699,458 Method of covering electric conductors; H. W. Dover, Northampton, England.

(Continued on page 78.)



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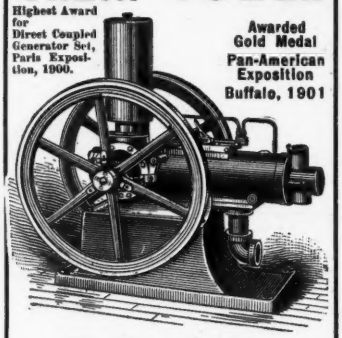
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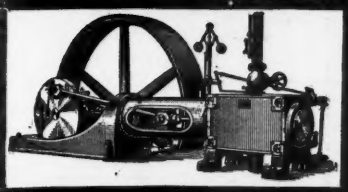

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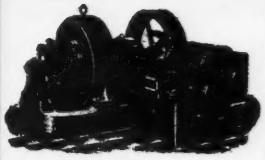

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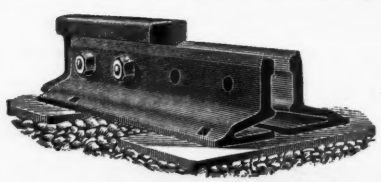

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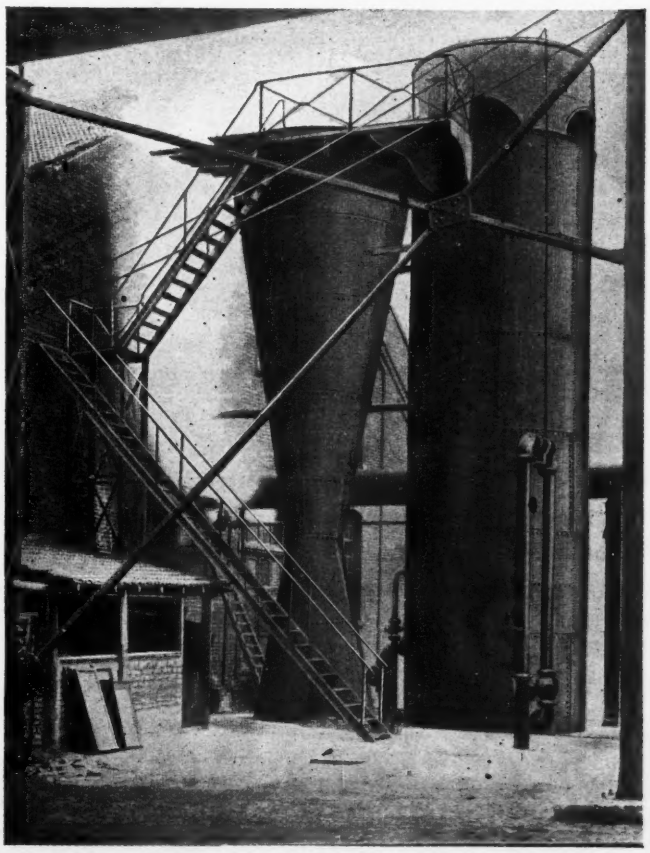

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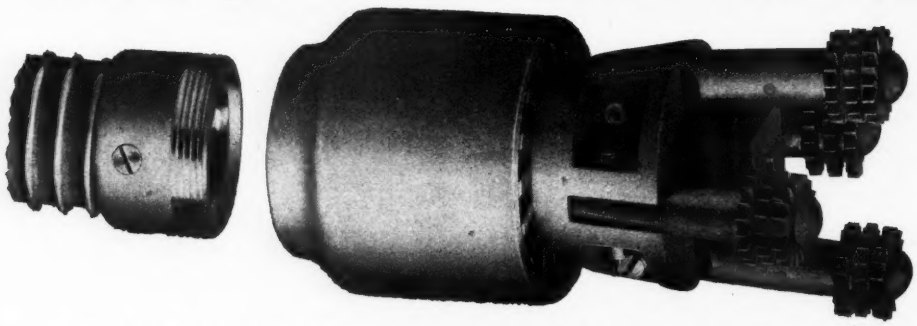

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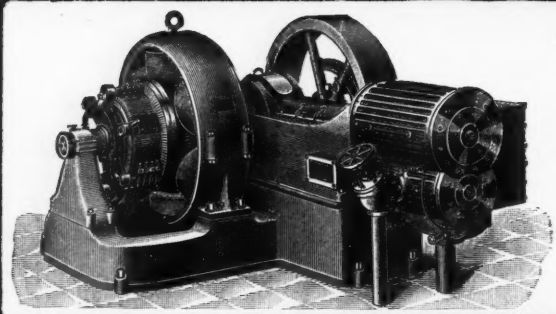

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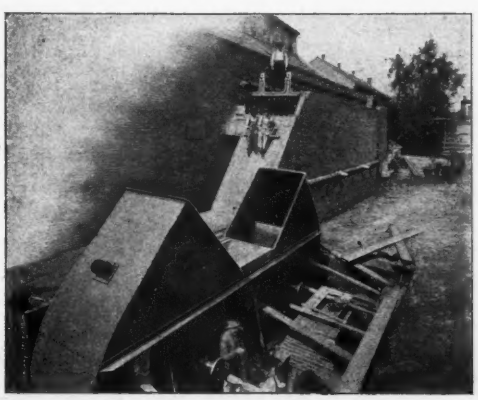

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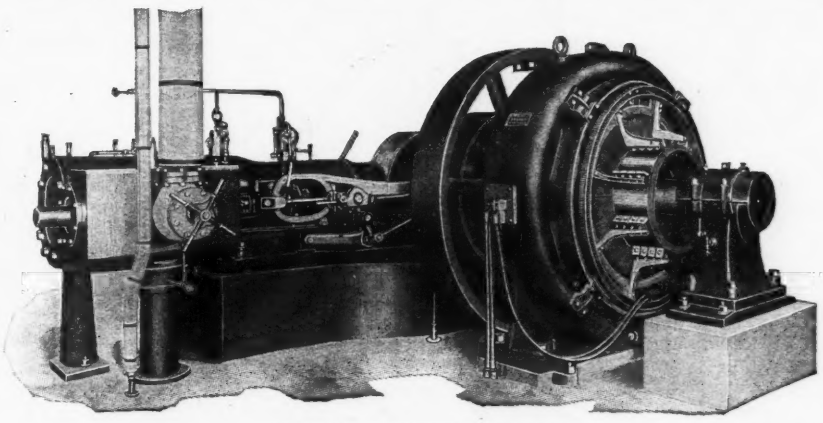

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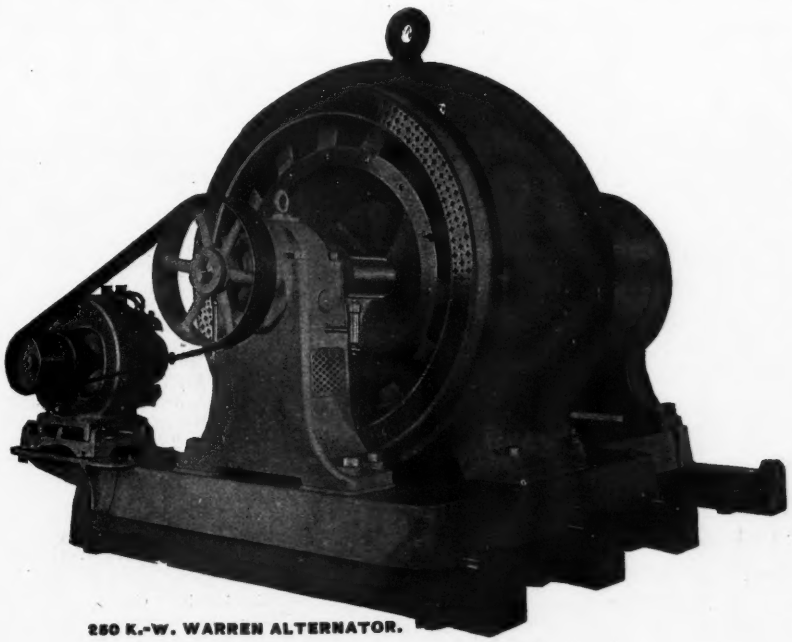

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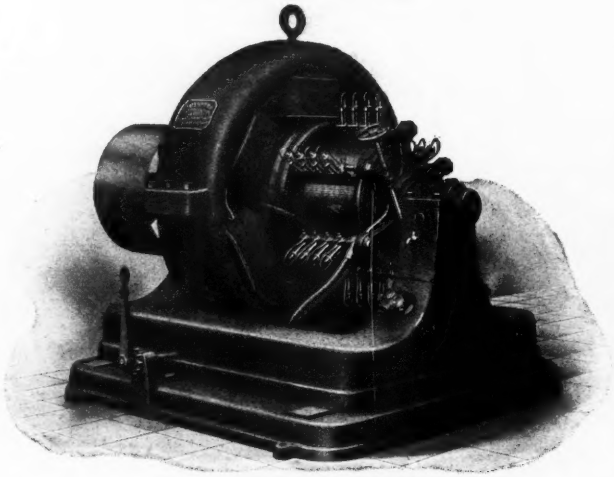

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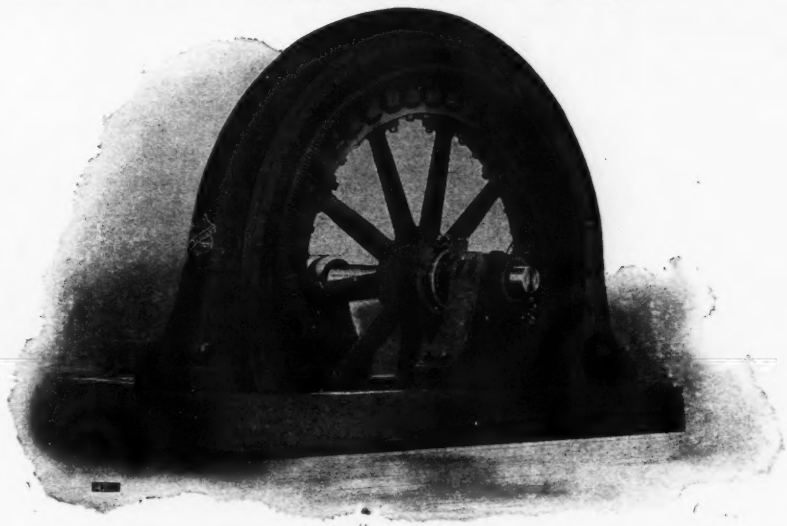

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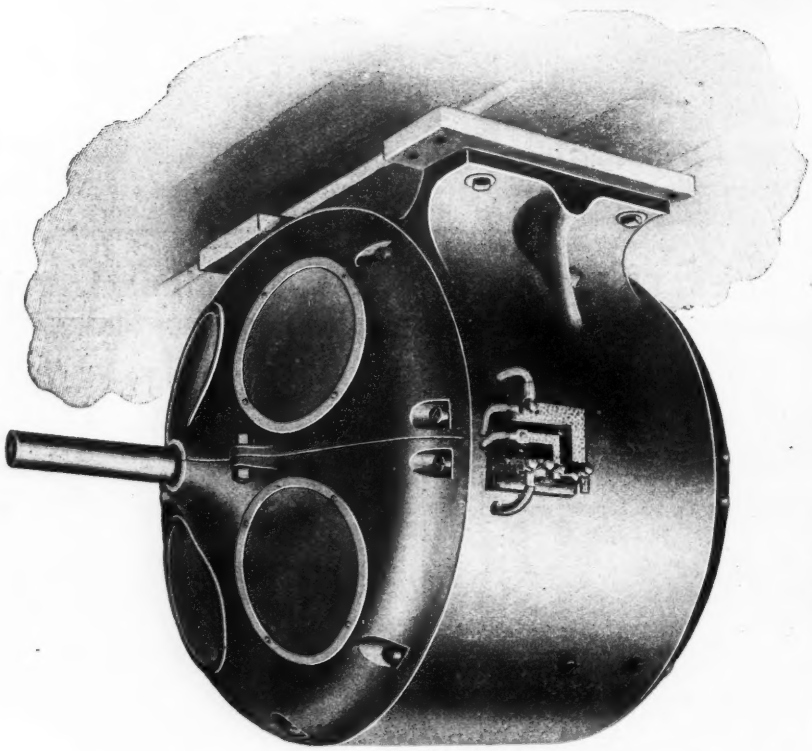

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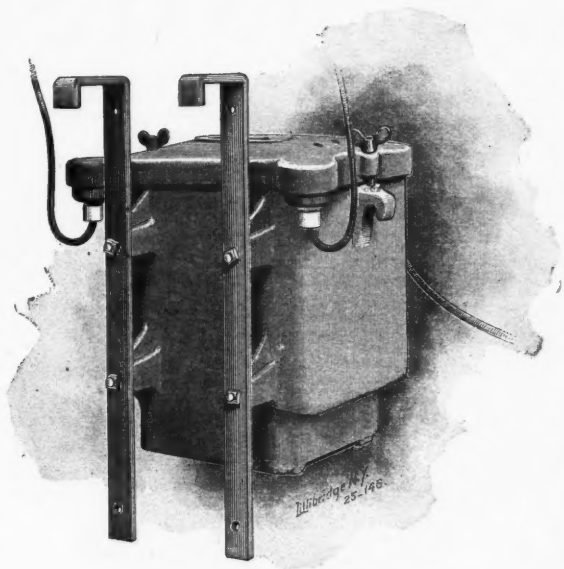

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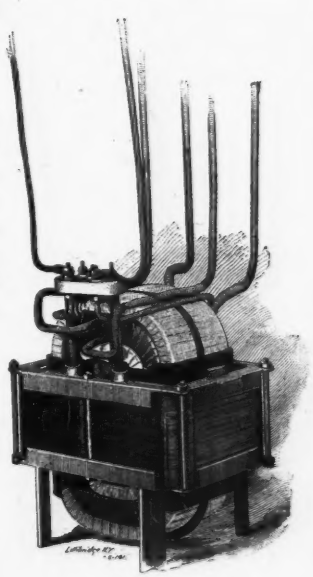

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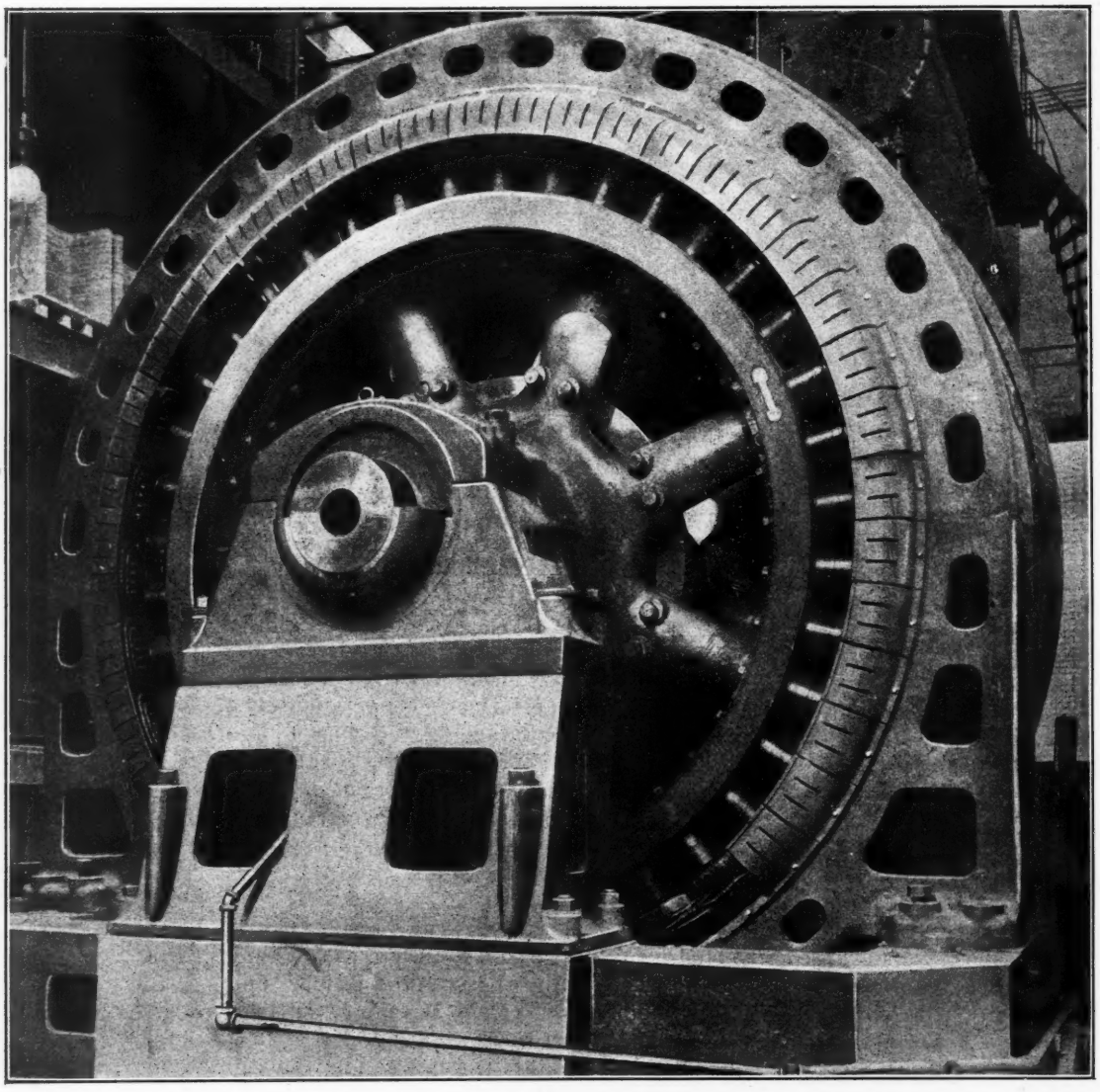

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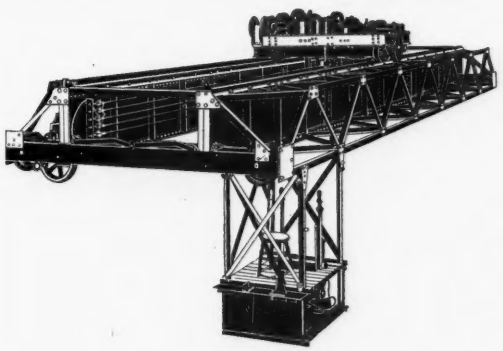

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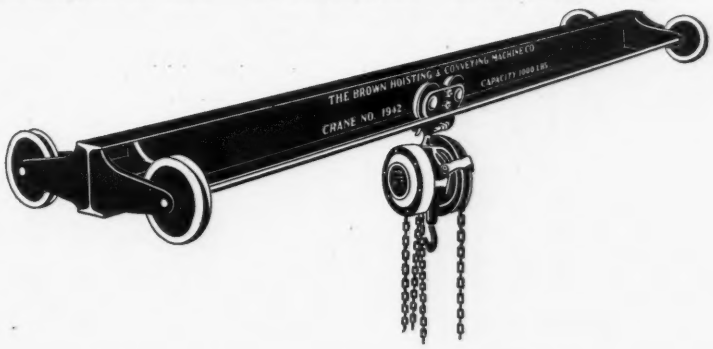

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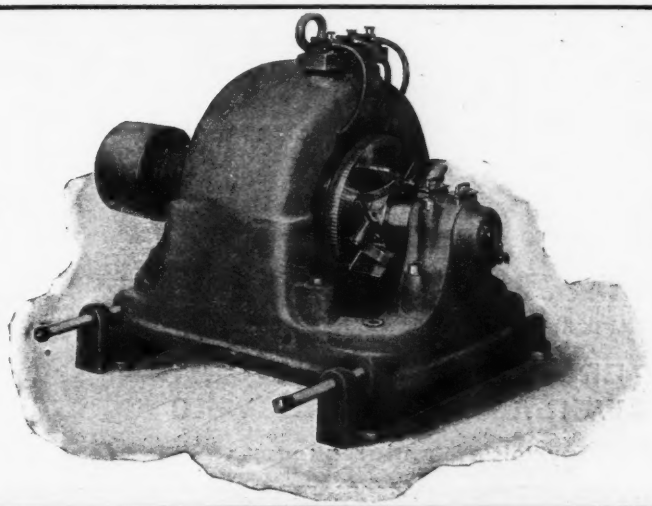

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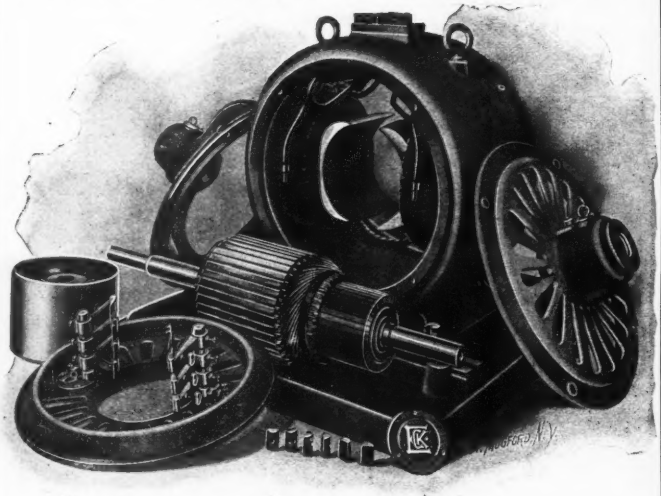

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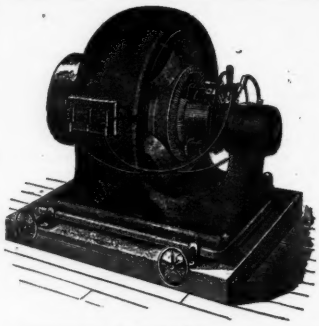

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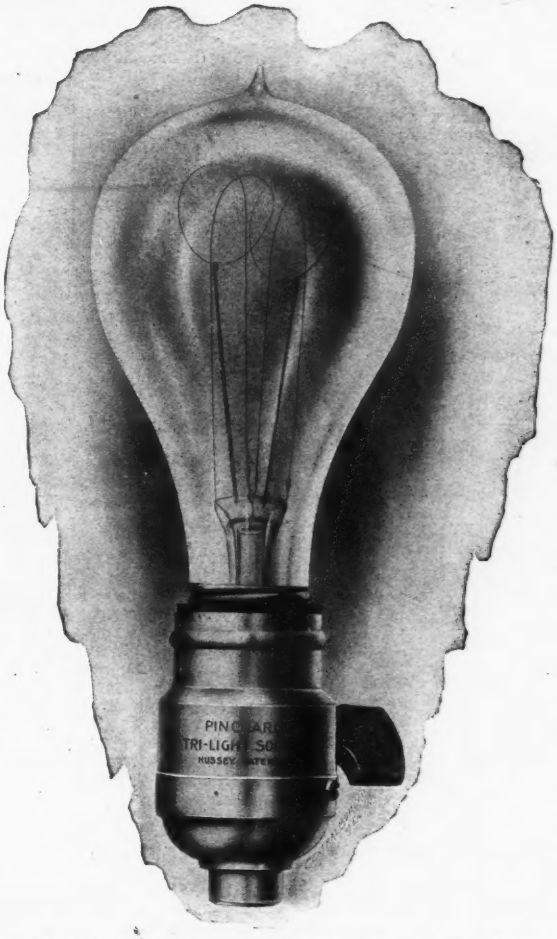

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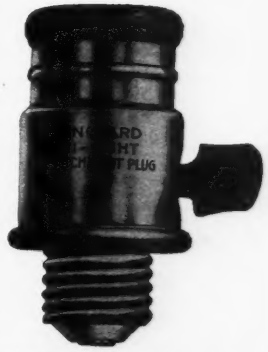

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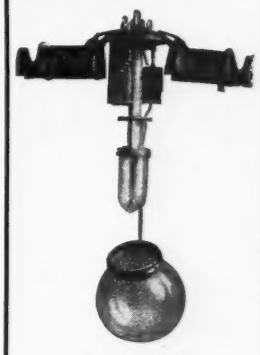

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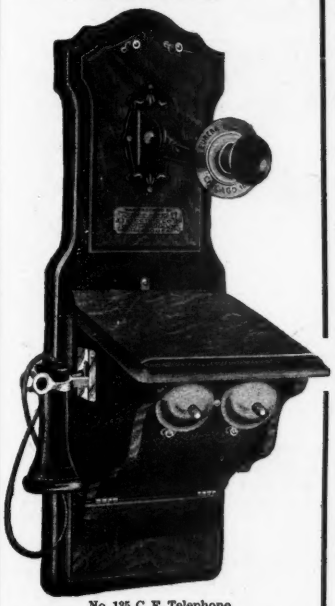

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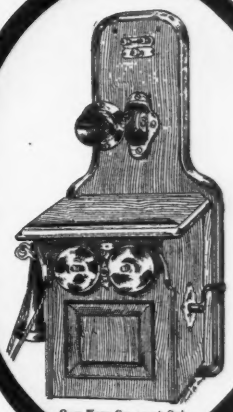

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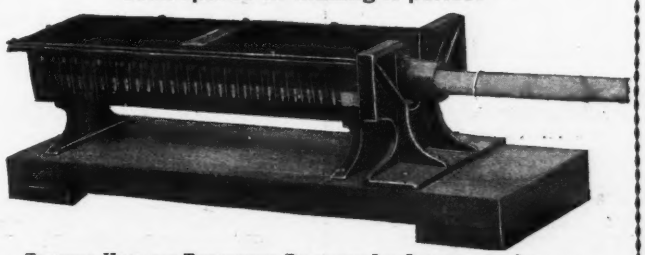

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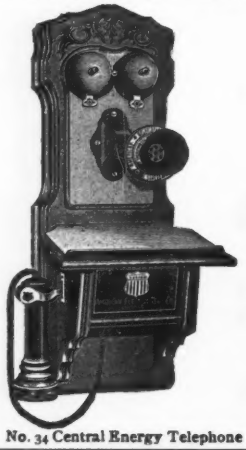

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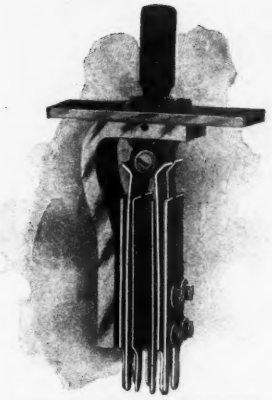

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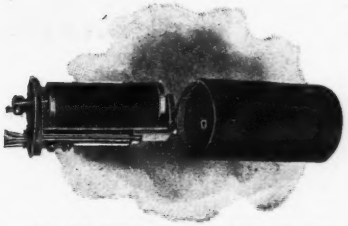

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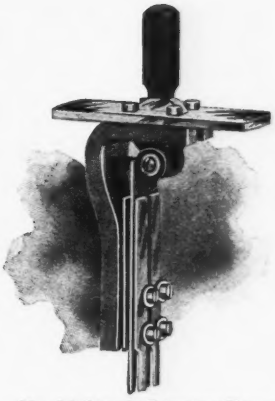

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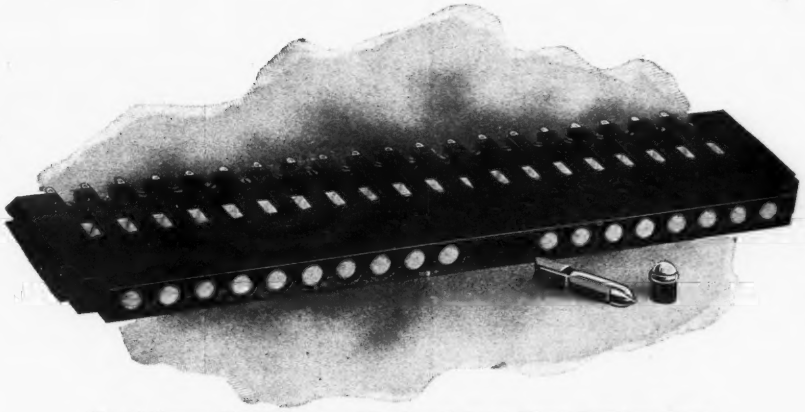

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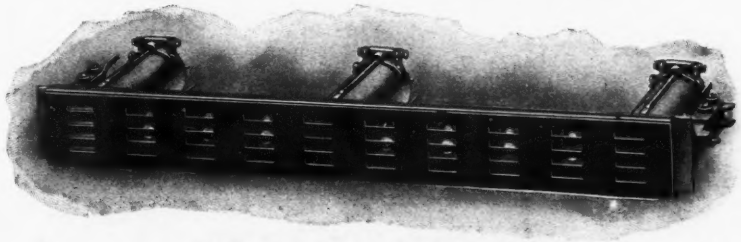

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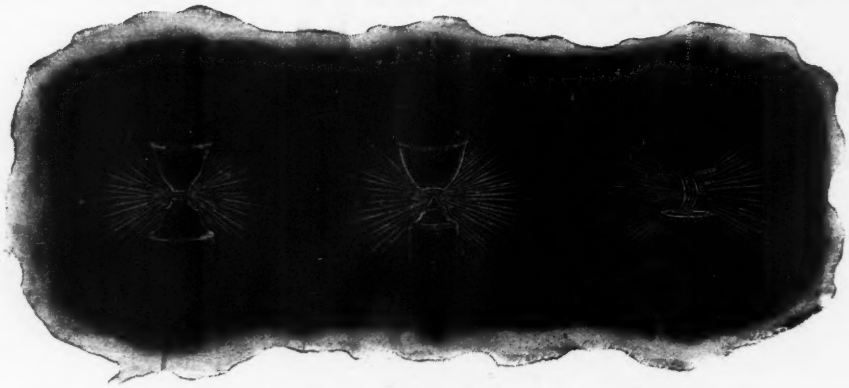

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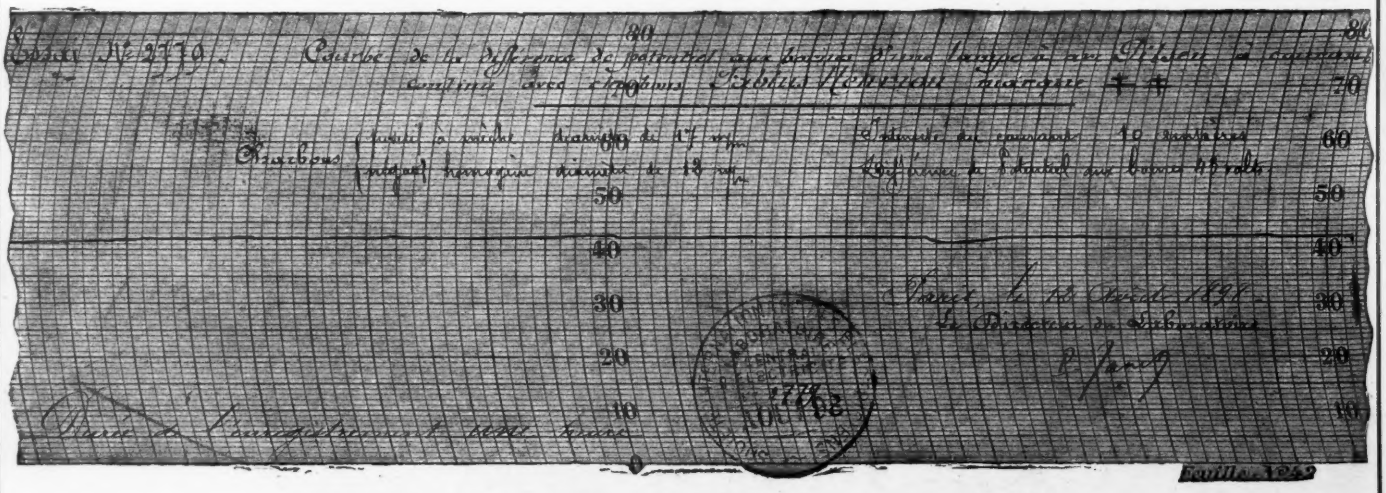

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